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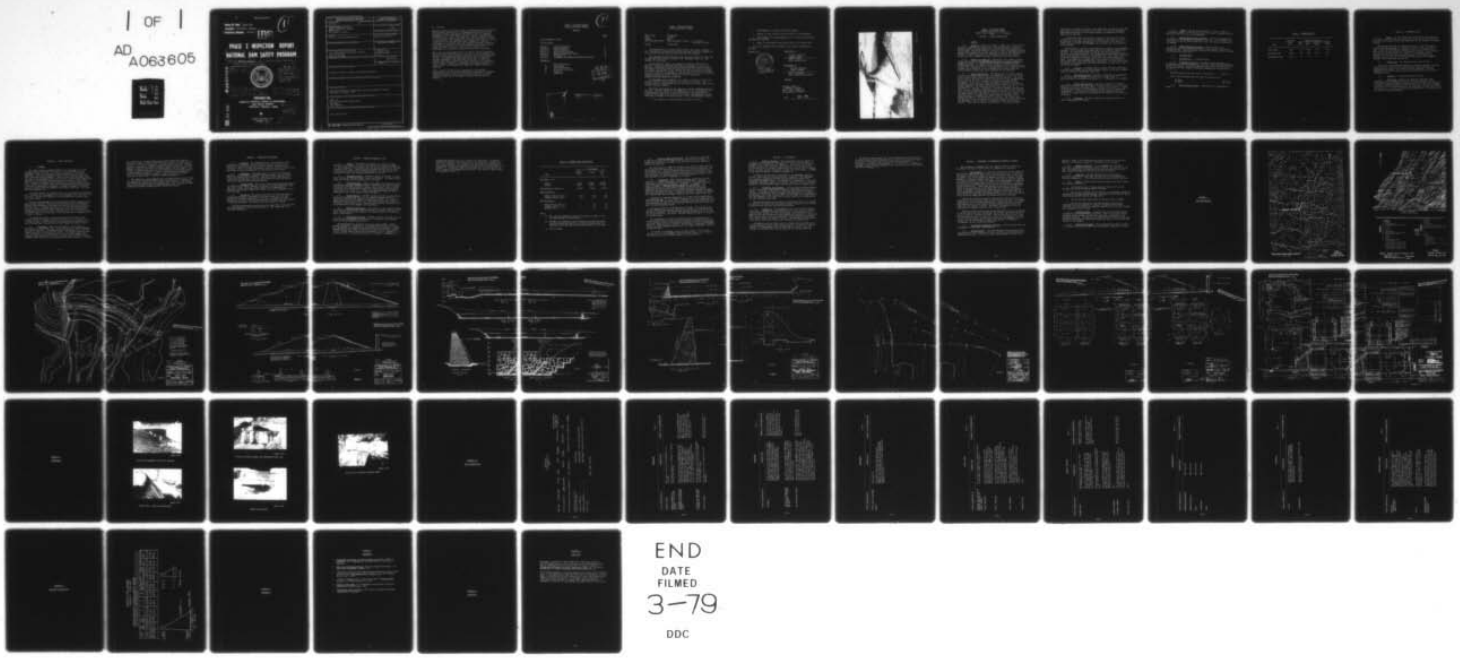

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JAMES RIVER BASIN

Name Of Dam: DOUTHAT DAM

Location: BATH COUNTY, VIRGINIA.

(Inventory Number: VA-01701).

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PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM.

Douthat Dam (~~Inventory Number~~ (VA 01701). James River Basin. Bath County, Virginia. Phase I Inspection Report.

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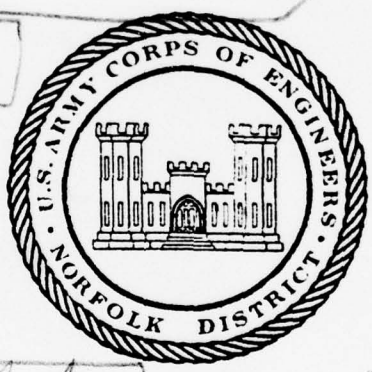

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DACW65-78-D-1014

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BY

GILBERT ASSOCIATES, INC.
SEPTEMBER, 1978

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20. Abstract

Pursuant to Public Law 92-367, Phase I Inspection Reports are prepared under guidance contained in the recommended guidelines for safety inspection of dams, published by the Office of Chief of Engineers, Washington, D. C. 20314. The purpose of a Phase I investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general conditions of the dam is based upon available data and visual inspections. Detailed investigation and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

Based upon the field conditions at the time of the field inspection and all available engineering data, the Phase I report addresses the hydraulic, hydrologic, geologic, geotechnic, and structural aspects of the dam. The engineering techniques employed give a reasonably accurate assessment of the conditions of the dam. It should be realized that certain engineering aspects cannot be fully analyzed during a Phase I inspection. Assessment and remedial measures in the report include the requirements of additional indepth study when necessary.

Phase I reports include project information of the dam and appurtenances, all existing engineering data, operational procedures, hydraulic/hydrologic data of the watershed, dam stability, visual inspection report and an assessment including required remedial measures.

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

CONTENTS

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

Name of Dam:	Douthat Dam
State:	Virginia
County:	Bath
USGS Quadrangle Sheet:	Healing Springs, Virginia (7-1/2 minute, 1969 photo revised)
Stream:	Wilson Creek

The Douthat Dam is a 55-foot high by 676-foot long zoned, earthfill dam. The dam has a 200-foot wide overflow spillway on the left abutment and a 5-1/2-foot by 6-foot concrete outlet near the left abutment.

The inspection found a few minor items requiring repairs, but there was no indication that the dam is presently in a hazardous condition. (See Appendix VI, Conditions.)

The spillway was found to be inadequate according to the Corps of Engineers' inspection guidelines described in paragraph 5.8, but it will pass up to 46 percent of the probable maximum flood (PMF) before the dam is overtopped. The one-half PMF will overtop the dam by 0.2 feet and the PMF will overtop the dam by 2.8 feet. Because the one-half PMF will be unlikely to cause a failure of the embankment, the spillway is not rated as "seriously inadequate" under the criteria of the U.S. Corps of Engineers' Engineer Technical Letter No. 1110-2-234.

The embankment section appears to be stable on the basis of the visual inspection and available design data, but needs to be verified. The spillway section, a masonry gravity dam, was found to be stable under all the loading conditions examined.

Based upon the findings of the inspection, several recommendations have been made. The most significant recommendations are the establishment of a warning system in the event of high runoff periods, the undertaking of a foundation investigation to verify the stability of the embankment, and the monitoring of seepage in the spillway area. Other recommendations include:

1. Minor repairs of riprap surfaces and areas of erosion.

2. Establishment of an annual inspection program.

3. Removal of trees from the crest and slopes of the embankment.

4. Establishment of a Design Document file to contain all pertinent information on the dam.

5. Repair of the broken 36-inch outlet gate out the intake tower.

It is also suggested that consideration be given to enlarging the spillway.

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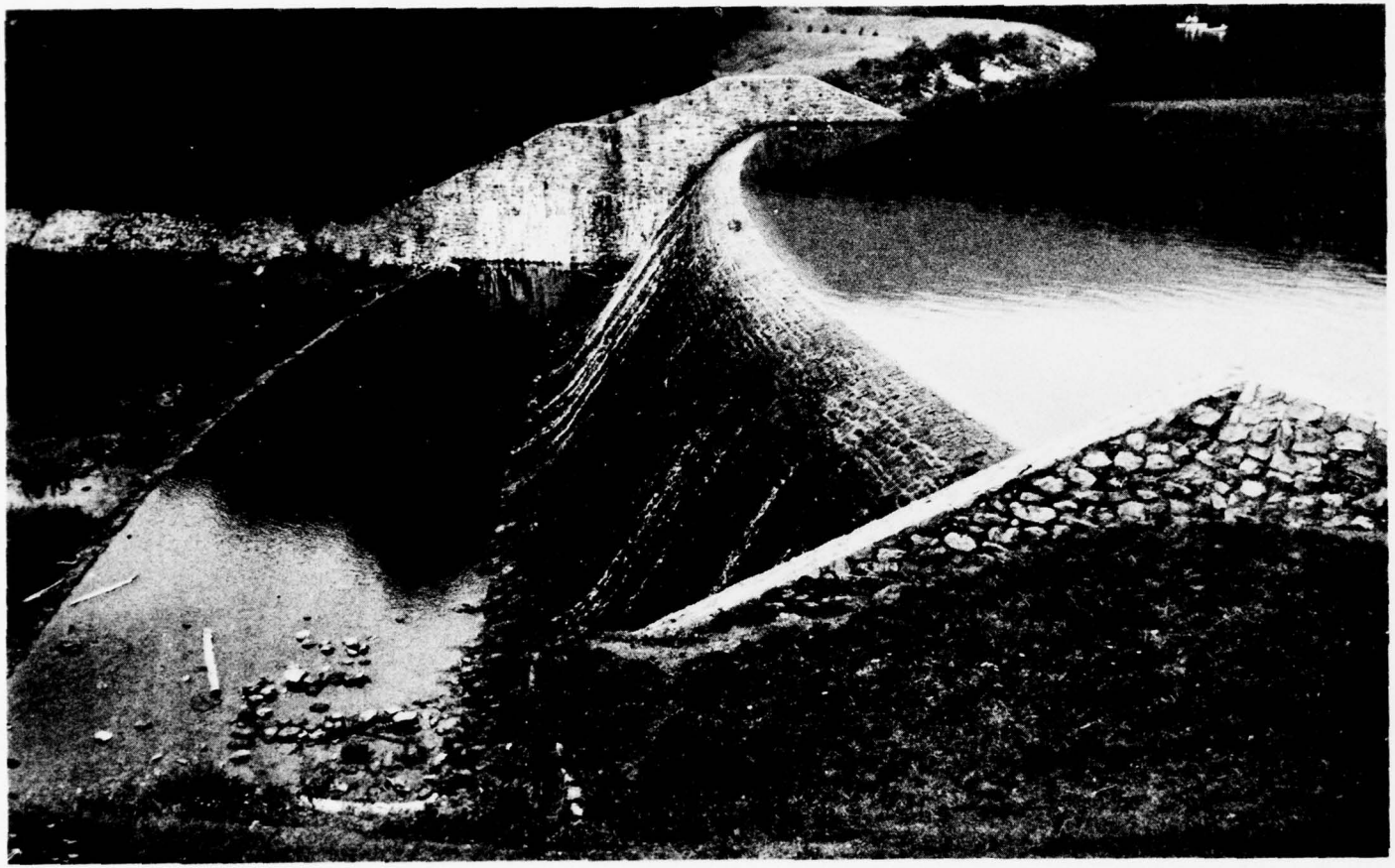


August 1978

OVERVIEW PHOTO OF DOUTHAT DAM AND SPILLWAY

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
NAME OF DAM: Douthat I.D. #: VA 01701

SECTION 1 - PROJECT INFORMATION

1.1 General

1.1.1 Authority: Public Law 92-367, 8 August 1972, authorized the Secretary of the Army, through the U.S. Corps of Engineers to initiate a national program of safety inspections of non-Federal dams throughout the United States. The Norfolk District of the U.S. Corps of Engineers has been assigned the responsibility of the inspection of dams in the Commonwealth of Virginia. Gilbert Associates, Inc. has entered into contract with the Norfolk District to inspect this dam, Gilbert Work Order 06-7250-005.

1.1.2 Purpose of Inspection: The purpose is to conduct a Phase I inspection according to the Recommended Guidelines for Safety Inspection of Dams (Reference 1 of Appendix V) and contract requirements between Gilbert Associates, Inc. and the Corps of Engineers. The objectives are to expeditiously identify whether this dam apparently poses an immediate threat to human life or property, and to recommend future studies and/or any obvious remedial actions that may be indicated by the inspection.

1.2 Project Description: The Douthat Dam is a 55-foot high by 676-foot long, zoned earthfill dam. The embankment is laid out in a long radius curve with the curvature extending into the reservoir. The stone, gravity section spillway is located at the left end of the embankment and it too is laid out in a curve, though in an opposite direction to the embankment. According to the design drawings, the earthfill dam has a central impervious core which forms the full top width of 15 feet and then extends downward to the underlying bedrock with a side slope of 1/4 horizontal to 1 vertical. According to the design drawings, the upstream shell consists of compacted impervious material of "lesser grade" than the core with an upstream slope varying from 2-1/2 horizontal to 1 vertical on the upper section to 3 horizontal to 1 vertical on the lower section. The downstream shell is designed with compacted pervious material with an downstream slope of 2-1/2 horizontal to 1 vertical. Two 10-foot wide benches are placed at elevations 1445 and 1427 along the downstream slope of the embankment. The toe section is designed with very free draining material. There are two concrete cutoff walls. A 24-inch high double

cutoff wall is located at the base of the impervious core zone and a 24-inch high single cutoff wall is placed at the base of the upstream embankment approximately one-third of the distance between the upstream toe and the center line of the dam.

A reinforced concrete gate tower is located in the reservoir at the upstream toe of the dam. Two 36-inch rectangular sluice gates are located at the base of the tower and open into a 5-1/2-foot by 6-foot concrete conduit which runs under the embankment and discharges near the downstream toe of the dam.

The spillway is a gravity section composed of carefully placed cemented stonework. It has on ogee crest shape and a crest length of approximately 200 feet. The downstream channel is wide and flat with side slopes protected by mortared stonework. The discharging flow undergoes a number of drops, first falling 23 feet over the spillway, then about 2 feet each over two small intermediate structures, and 15 feet into a stone plunge pool basin. The plunge pool no longer holds water because of the failure of a small stone wall at the downstream end of the basin. The water drains over the remains of the broken wall and drops approximately 5 feet into a pool at the end of the channel.

1.2.2 Location: The Douthat Dam is located on Wilson Creek about 7.0 miles north of the city of Clifton Forge, Virginia on the state highway Route No. 629 within the Douthat State Park.

1.2.3 Size Classification: The dam is classified as intermediate in size based upon the height of 55 feet and a storage volume of 1,450 acre-feet in accordance with Section 2.1.1 of Reference 1 of Appendix V.

1.2.4 Hazard Classification: The dam is located in a sparsely populated flood plain area but is about 7.0 miles above the city of Clifton Forge and the town of Cliftondale Park. The dam is classified as a "high" hazard potential based on the requirements of Section 2.1.2 of Reference 1 of Appendix V. The hazard classification used to categorize dams is a function of location only and is unrelated to the stability or probability of failure.

1.2.5 Ownership: The dam is owned by the Virginia Division of Parks, Commonwealth of Virginia.

1.2.6 Purpose: The dam was constructed to create a lake for recreational purpose. The water level is controlled by an ungated overflow spillway to the left side of the embankment.

1.2.7 Design and Construction History: The dam was engineered by the Bureau of Land Management, Department of Interior, in 1934-1935, and constructed by the Civilian Construction Corps. The dates of construction are unknown.

1.2.8 Normal Operating Procedure: The dam relies on an uncontrolled overflow across the spillway to pass excessive storm flows through the lake. From mid-October to March, the reservoir level is lowered 20 to 25 feet for weed control.

1.3 Pertinent Data

1.3.1 Drainage Area: 17.0 square miles.

1.3.2 Discharge at Dam Site: According to park employees, the maximum historic flood at the dam site occurred in 1969 from runoff produced by hurricane Camille. Reportedly the water level rose to within 1-foot of the crest of the dam, giving an estimated discharge over the spillway of 14,120 c.f.s.

Spillway discharge with pool level at top of dam . . . 17,560 c.f.s.

Outlet works discharge with pool level at spillway crest:

One gate	262 c.f.s.
Two gates	524 c.f.s.

1.3.3 Dam and Reservoir Data: Pertinent data is summarized in Table 1.1.

Table 1.1 RESERVOIR DATA

Item	Elevation Feet m.s.l.	Reservoir Capacity			
		Area acres	Acre feet	Watershed inches	Length miles
Top of Dam	1,453	79	1,450	1.60	0.61
Spillway Crest	1,445	60	900	0.99	0.53
Streambed at Dam	1,410	0	0	0	0

SECTION 2 - ENGINEERING DATA

2.1 Design: The only design data available for the inspection are a plan, cross-sections, and profiles of the dam and spillway, which are provided by the Virginia State Park Commission (Mr. Ron Sutton) in Richmond, Virginia.

The drawings show that the impervious earth core and the concrete cutoff walls were designed to be founded on bedrock. The site under fill east of line A-B (see Figure 3, Appendix I) was to be stripped to rock. West of line A-B the site was to be stripped of loam only. Line A-B was to be located in the field where soil ceases to show reworked alluvial deposits, such as loam, silt, and sand deposits. The foundation for earthfill at the cliff near the east end of the dam was to be stepped to provide a more stable base for the fill.

2.2 Construction: No construction data were provided.

The spillway and downstream channel are presently undergoing a gradual rehabilitation. Each year after the recreation season and until the freezing weather begins, the stonework is being regrouted. The work commenced in 1977 and to date has covered the end walls and a few feet of the spillway crest.

2.3 Operation: No operating records are kept.

2.4 Evaluation: There are no foundation exploration and construction data, or design calculations and data available, and the description of the zoned material shown on the design drawing was inadequate to enable a complete evaluation of the dam stability. The spillway channel profile shown in the design drawing is not consistent with what was observed in the field; i.e., a drop at the end of the plunge pool of the spillway was not shown on the design drawings.

SECTION 3 - VISUAL INSPECTION

3.1 Findings

No surface cracks or unusual movement at or beyond the toe of the earthfill dam were observed. The crest is in good alignment and the embankment slopes were relatively uniform and appeared to be properly maintained. Local areas between the upper and lower benches showed some minor scattered surface sloughing. A minor erosion gully extending across the crest to the downstream face in the vicinity of the spillway endwall has developed in an area where the grass surface was removed. Three trees, about 12 inches in diameter, stand separately on the upstream side of the crest. There are two small areas along the downstream banks beyond the toe of the dam in which water is standing. Although no seepage was observed, the pools indicate that some leakage is occurring in this area. (For more detail see Appendix III).

A concrete outlet, 5-1/2 feet by 6 feet, is located near the downstream toe. The drain was discharging water at an estimated rate of 100 g.p.m. to 150 g.p.m. The water was reddish in color and, therefore, probably high in iron oxide content.

The crest and uppermost portion of the spillway surface appear to have been recently repaired. There are several missing stones in the masonry paving at the mid-height on the lower weir surface (see Overview Photo on the front page). A seepage condition exists in two areas of the spillway. One area is located on the lower mid-portion of the weir surface where concentrated red stains are shown. The other area lies at the base of the downstream endwall on the left end of the spillway with an estimated flow of 1 g.p.m. to 2 g.p.m.

The downstream channel is paved with stones near the base of the spillway and the side slopes are paved with stone on a 1 horizontal to 1 vertical slope. A small failure in the slope has occurred near the left end of the spillway, but there were no other significant signs of wear.

3.2 Evaluation: There does not appear to be any serious deficiencies in the earthfill dam. There are only minor surface sloughing and erosion conditions. The seepage condition beyond the toe of the dam presents no hazard to the safety of the dam. The seepage condition at the lower mid-portion of the downstream face of the spillway suggests that leakage through the masonry structure itself may have developed along the permeable paths created by poor bonding between stone and mortar or leaching

out of the mortar. Periodic monitoring of this seepage area should be conducted in order to assess further its significance to the safety of the structure. This type of seepage is considered undesirable, and a remedial measure to eliminate or reduce the seepage should be considered. The minor seepage occurring at the bottom of the left endwall does not appear to be serious. A periodic monitoring of this seepage area to detect any increase in flow should be carried out. Initially, the monitoring program should check the seepage at monthly intervals. Once the pattern of seasonal variation is established, it should be checked semiannually.

The completion of the stonework which was begun last year, will correct the only serious surface deficiency noted in that structure. However, all the seepage exits observed in the stonework and at the toe of the endwall should not be blocked during the continuing repair work, so as not to build potentially hazardous internal pressure within the structure.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 Procedures: No documented plan for the operation of the Douthat Dam is available. The flow of water over the spillway is not controlled. The only operational procedure currently followed by the Division of Parks is to lower the reservoir level by 20 feet to 25 feet from mid-October to the following March for the purpose of weed control.

4.2 Maintenance: The maintenance is carried out by the Park employees. The spillway is presently undergoing repairs but only during about a one month period in the fall. The work involves regrouting the stonework of the spillway; so far the spillway end walls and the top few feet of the spillway crest have been repaired.

4.3 Warning System: There is no formal warning system maintained by the Division of Parks. However, according to the park supervisor, when the river is high, the access roads to some of the campgrounds are submerged, and therefore campers are warned to leave or be prepared to stay for a few days.

4.4 Evaluation: The dam does not have a written operating and maintenance procedure. Maintenance at the dam is good as far as weed control and the general appearance of the dam is concerned, but other maintenance, at least until the recent repairs were begun last year, appears to have been neglected. The broken outlet gate should be repaired.

Planting and growing of young trees on the upper berm of the downstream face (see Appendix II) should be considered as a poor operational and maintenance procedure.

SECTION 5 - HYDRAULIC/HYDROLOGIC DATA

5.1 Design: The hydraulic design data is limited to those features of the spillway and outlet works shown on the drawings (Appendix I). The configuration of the gate tower and spillway appear to be the same as shown on the plans. Some differences between the plans and the actual construction were noted on the downstream channel, but these would not significantly affect the hydraulic performance of the dam.

5.2 Hydrologic Records: The most significant rainfall in recent years occurred in 1969 as a result of hurricane Camille. In nearby Clifton Forge 10.12 inches of precipitation fell in 13 hours.

5.3 Flood Experience: There are no gages on the reservoir and no records have been kept on maximum floods. Reportedly, the flood resulting from hurricane Camille produced a reservoir level within 1 foot of the top of the dam. Our calculations provide an estimated spillway discharge for that condition of 14,120 c.f.s. There was no knowledge among the people managing the site of the dam ever being overtopped.

5.4 Flood Potential: The PMF, one-half the PMF, and the 100-year floods were determined for this site by a method developed by the Soil Conservation Service using regional precipitation values. The results of these studies are given in Table 5.1. These analyses pertain to present hydrologic conditions and do not consider future uncertain conditions, such as urbanization or other changes in the watershed.

5.5 Reservoir Regulations: The reservoir is not regulated during the normal recreation season, being maintained at the level of the spillway crest. During the winter the reservoir is lowered 20 feet to 25 feet as a means of weed control.

5.6 Overtopping Potential: The PMF, one-half of the PMF, and the 100-year flood hydrographs were developed for the Douthat Lake drainage basin and routed through the reservoir.

The hydrographs were developed and routed using the HEC-1 computer program (Reference 2 of Appendix V) and appropriate precipitation, losses, unit hydrograph, and storage volume versus outflow data as input. Probable maximum precipitation (PMP) and 100-year precipitation data were obtained from U.S. Weather Bureau publications (References 3 and 4 of Appendix V). A reduction factor of 18 percent was applied to the PMP as recommended for a

drainage basin with an area of 17 square miles (Reference 5 of Appendix V). Losses were estimated at an initial loss of 1.0 inch and a constant loss rate of 0.3 inch/hour. The triangular unit hydrograph was developed from the drainage area and an estimated time to peak of 3.3 hours (Reference 5 of Appendix V). Information from record drawings and field observations was used to compute the storage-outflow relation. The results of these studies are presented in Table 5.1.

Table 5.1 DOUTHAT LAKE FLOOD ROUTING

Item	Hydrograph		
	One Percent (a)	1/2 PMF	PMF (b)
Peak Flow, c.f.s.			
Inflow	7,260	19,420	38,800
Outflow	6,800	18,950	37,700
Peak Elevation, feet m.s.l.	1,449.4	1,453.2	1,455.8
Ungated Spillway			
Depth of flow, feet (c)	3.3	6.5	8.6
Average velocity, fps	10.3	14.3	16.6
Dam Overtopping			
Depth of flow, feet (c)	-	0.2	1.8
Average velocity, f.p.s.	-	2.1	7.3
Duration, hrs.	-	2.0	6.0

Notes:

(a) The 1 percent exceedance frequency flood has one chance in 100 of being exceeded in any given year.

(b) The PMF is an estimate of flood discharges that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region.

(c) Critical depth.

5.7 Reservoir Emptying Potential: The reservoir was designed to be emptied using two 36-inch sluice gates located in the gate tower. At present one of the gates is jammed in an open position and the opening is sealed with sand bags.

The time required to empty the reservoir was calculated based upon the outlet capacity with both gates in use and for the present condition of only one operating gate. Because volume-elevation curve for the reservoir was not available, an estimated curve was constructed for the calculation. With both gates open, the drainage period will be approximately 26 hours. With only one gate, the time is lengthened to 55 hours.

5.8 Evaluation: Three spillway capacity ratings are possible under the U.S. Corps of Engineers' inspection guidelines: Adequate; Inadequate; and Seriously Inadequate. (Reference 1 of Appendix V and U.S. Corps of Engineers' Engineer Technical Letter No. 1110-2-234). The screening criteria for assessing the adequacy of the spillway allow essentially no risk of loss of life from dam failure by overtopping. Experience indicates that very few existing non-Federal dams were designed with such conservative criteria. Therefore, the Phase I inspection findings will indicate that most non-Federal dams will have an inadequate spillway.

A spillway is considered inadequate if it cannot pass the PMF without overtopping the dam. It is seriously inadequate if it is overtopped by less than a one-half PMF that could lead to a failure of the dam, resulting in an increased hazard to loss of life downstream from that which would exist just prior to the overtopping failure.

The design flood for the Douthat Dam is the PMF. The results of our analysis show that the spillway can pass only 46 percent of the PMF before the dam is overtopped. The one-half PMF overtops the dam by up to 0.2 feet for a duration of up to two hours. The PMF overtops the dam by 2.8 feet for as long as 6 hours.

An overtopping of 0.2 feet as indicated in the calculations is not likely to lead to the failure of the dam, provided a suitable surface cover, as now presently exists, is maintained to prevent the erosion of embankment materials. Based upon this rationale, the spillway is considered inadequate but not seriously inadequate based on the U.S. Corps of Engineers' criteria referred to above.

If the dam is overtopped, erosion is most likely to occur at the junction of the earth embankment and the spillway endwall. If a breach of the dam were to occur, it would probably be at this location.

SECTION 6 - DAM STABILITY

6.1 Stability Analysis: The preliminary stability analysis of the masonry spillway weir was performed in accordance with the method in paragraph 4.4.4 of Reference 1 of Appendix V. The calculations (based on the PMF, one-half PMF, and normal operating level with ice loading and 100 percent uplift at the heel) indicate that the structure has an adequate factor of safety against overturning, sliding, and overstressing. A summary of the stability analysis is shown in Appendix IV.

A stability analysis was not available for the embankment portion of the dam. There were no visual indications of weakness in the embankment (e.g. piping or sloughing) and the existing slopes were typical for zoned-earth embankments (see p. 267, Reference 5 of Appendix V). The earth embankment, therefore, appears to be stable. However, a stability analyses should still be performed to assure that adequate factors of safety exist.

6.2 Foundation and Abutments: The rock exposed at both abutments consist of hard and fissile shale, slightly to moderately weathered and jointed. It belongs to the Brallier formation and is Devonian in age, on the basis of the Geologic Map of Virginia, 1963 (Reference 6 of Appendix V). The bedding of the strata strikes N 50°E and dips 55°SE to the downstream at the right abutment, and strikes N 25°E and dips 53°SE to the downstream at the left downstream cliff bank.

The masonry gravity weir and walls of the spillway were to be founded on bedrock in accordance with the design drawing. Earthfill was to be used between the left end walls and the existing ground.

6.3 Evaluation: The embankment section has relatively uniform side slopes. Seepages occurring beyond the toe are well within tolerable limits without causing soil erosion and piping. The foundation rock is generally hard and fissile shale with adequate bearing capacity. Some minor deficiencies, such as surface sloughing and erosion along the downstream slope, do not affect the safety of the dam. The embankment section appears to be stable on the basis of the visual inspection and design data.

The spillway weir was found to be in a stable condition under various loading conditions, based on the stability analysis. However, a stability analysis of the embankment should be performed in order to verify the existence of adequate safety factors under various loading conditions.

The dam is located within Zone 2 on the Algermissen Seismic Risk Map of the United States (1969 Edition) and there are uncertainities with respect to the static stability of the dam, as described in paragraph 6.1. Therefore, in accordance with paragraph 3.6.4 of Reference 1 of Appendix V, assessments should be made regarding seismic stability, based on the studies outlined in paragraph 7.2.3.

SECTION 7 - ASSESSMENT, RECOMMENDATIONS/REMEDIAL MEASURES

The assessment, recommendations, and remedial measures contained in this Report are based on the provisions of Appendix VI, Conditions.

7.1 Dam Assessment: On the basis of the visual field inspection and available engineering, operational, and performance data, the earthfill dam appears adequately designed and does not now exhibit any critical signs of distress, e.g. severe leakage or seepage, structural cracking, abnormal movement, or unstable abutment conditions. Some areas of surface sloughing and erosion, especially in the area where the earth embankment is connected to the end wall of the spillway, will need to be rehabilitated in order to stabilize the established slope and the contact zone between the embankment and the spillway wall. Three trees growing on the crest of the dam could result in root penetration of the impervious core and might eventually result in leakage. The growing of some young pine trees on the upper berm of the downstream face would eventually degrade the integrity of the dam after the death of the trees and rotting of their roots. One of the 36-inch sluice gates was jammed open and the opening sealed with sand bags.

A preliminary stability analysis indicates that the stability of the spillway weir is satisfactory under various loading conditions. The seepage conditions on the face of the spillway and at the base of the left endwall might develop into a safety hazard if these progress beyond the critical limit and cause erosion or piping. Therefore, they should be monitored semiannually or whenever the pool level is above normal.

The flood studies indicate that the spillway will pass up to 46 percent of the PMF before the dam is overtopped and the PMF will overtop the dam by up to 2.8 feet for a period of 6 hours. The one-half PMF will just barely overtop the dam by up to 0.2 feet for 2 hours. An overtopping of 0.2 feet is not likely to lead to the dam failure, provided the embankment face and material are well maintained; therefore, the spillway is considered "inadequate" but not "seriously inadequate".

7.2 Recommendations/Remedial Measures: The following actions are recommended for the owner's consideration:

7.2.1 Warning System: A detailed emergency warning system should be developed as soon as possible to notify the downstream inhabitants of an impending dam failure. In order for the warning system to be effectively

applied, a study of the downstream area should be made so that the areas subject to flooding as a result of a dam break can be identified.

7.2.2 Inspection Program: It is recommended that the owner establish a semiannual inspection program to monitor the conditions at the dam. The program should include monitoring and measuring the flow rate where feasible through the spillway and at the left endwall.

7.2.3 Stability: The owner should obtain the services of a qualified consultant to investigate the stability of the embankment as stated in paragraph 6.1. This task should be carried out within 180 days.

7.2.4 Repairs: Several areas requiring repairs were noted during the inspection as follows:

a. The failed section of riprap slope near the end wall of the spillway weir should be repaired within 12 months.

b. The surface sloughing and erosion area on the embankment should be stabilized with redressing and seeding. Additional fill and top soil may be needed where excessive erosion has taken place.

c. The 36 inch outlet gate should be repaired within 12 months.

d. The trees on the crest of the dam and those planted on the downstream slope (see Appendix II) should be removed and the stumps extracted, the holes filled with compacted impervious soil and the disturbed area recompacted within 60 days.

7.2.5 Design Documents: A complete set of all available design documents should be maintained by the owner. These files should include available design drawings, calculations, pertinent correspondence, and maintenance records. In addition, the attempt should be made to obtain all available information on past design changes and repairs to the dam and the reasons for the changes.

7.2.6 Spillway Enlargement: Future consideration should be given to enlarging the spillway to meet Corps of Engineers' inspection criteria.

APPENDIX I

MAPS AND DRAWINGS

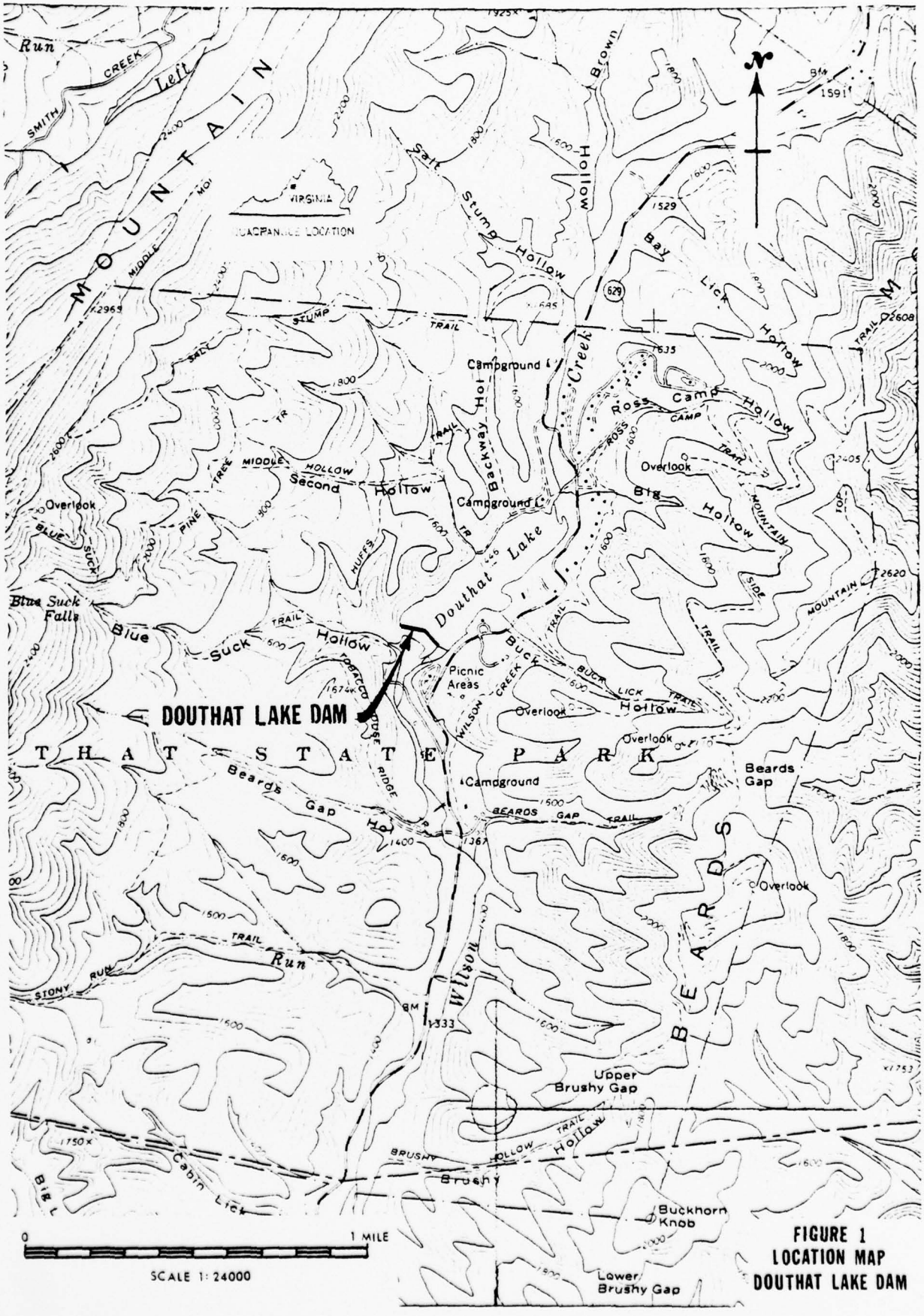
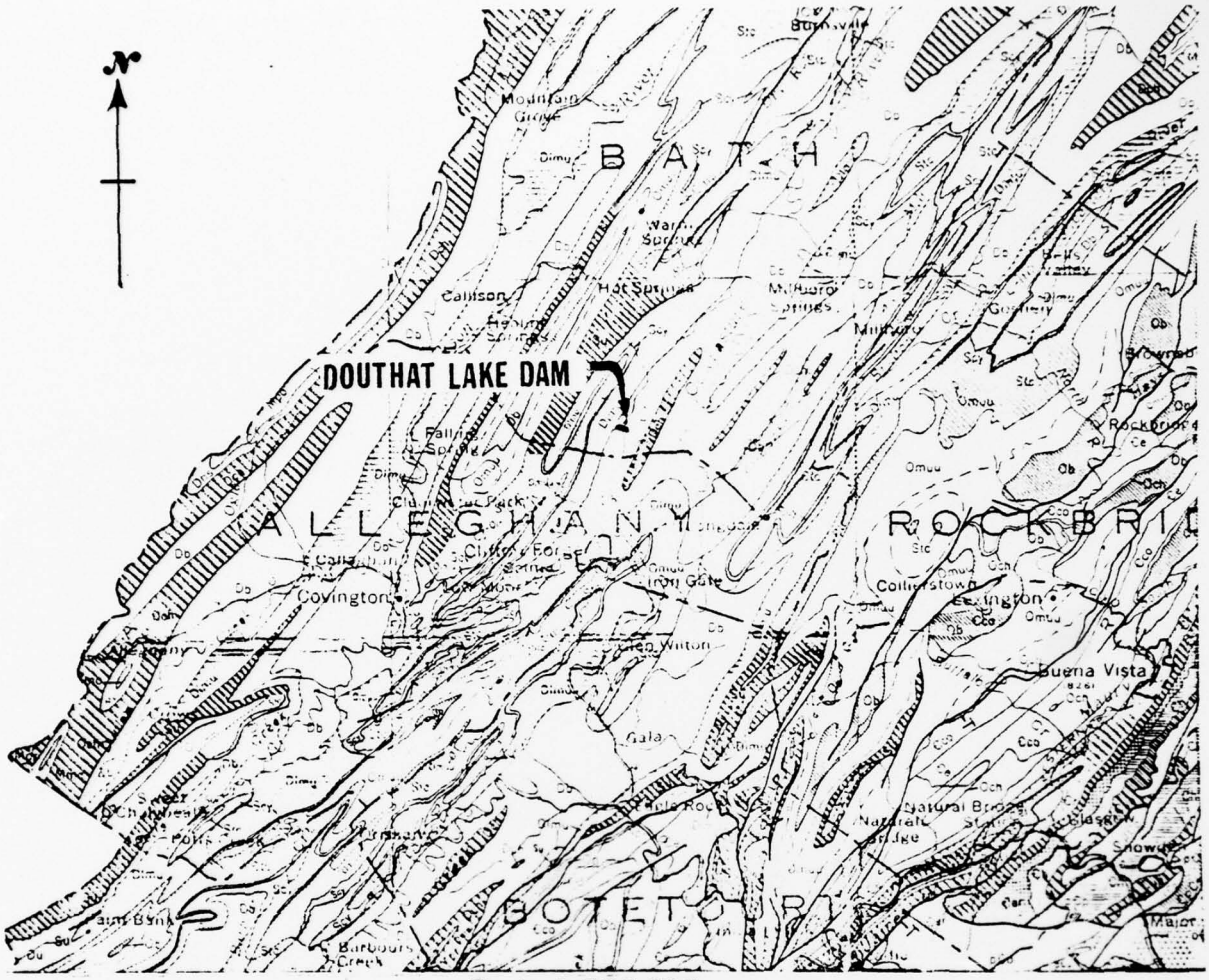


FIGURE 1
LOCATION MAP
DOUTHAT LAKE DAM



Scale 1:500,000

1 inch equals approximately 8 miles

10 0 10 20 30 40 Miles

DEVONIAN

Dch

Chemung formation

Shale and sandstone, mostly gray and greenish gray, fossiliferous.

Db

Brallier formation

Shale, greenish gray, siliceous; and sandstone, greenish, fine-grained thin-bedded.

Dlmu

Devonian formations, Lower and Middle, undivided

Includes units mapped as Linneymans limestone, New Scotland limestone, Helderberg sandstone, Licking Creek limestone, Beerkeft limestone, Rocky Gap sandstone, Genesee shale, Ridgely (Keyser) sandstone, Huntersville chert, Needmore shale, Onondaga formation, Millboro shale, Mucellus shale, and Hamilton formation. Upper portion of Millboro shale may be Upper Devonian.

SILARIAN

Scy

Cayuga group

Includes McKenzie, Bloomsburg, Wills Creek, Tonoloway, and Keyser formations in west-central and northwestern Virginia, and Lancock dolomite in southwestern Virginia.

Sb

Silurian formations, undivided

Sc

Clinton formation

Shale and sandstone with beds of fossiliferous, hematitic sandstone.

Tuscarora formation

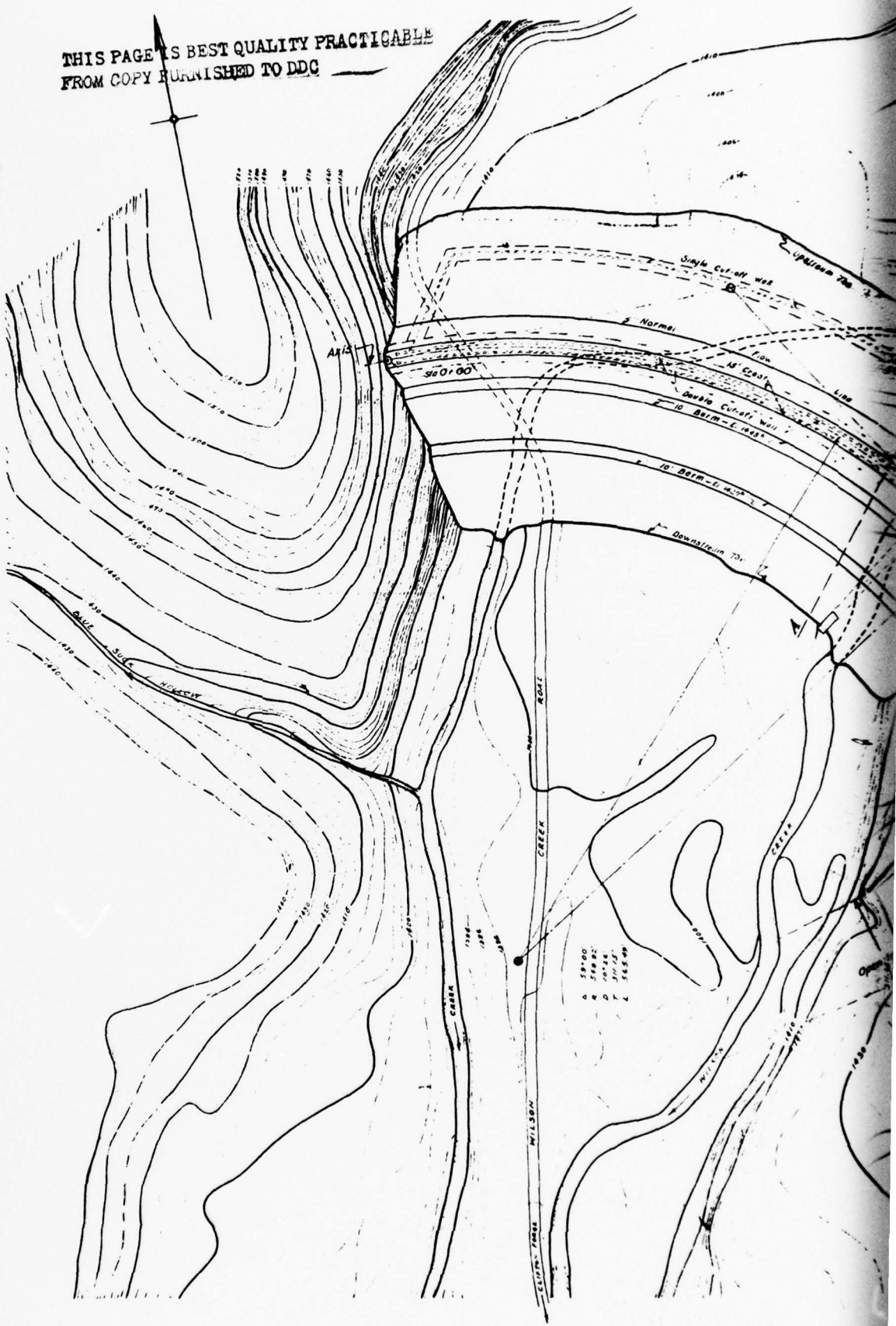
Quartzite, thick-bedded.

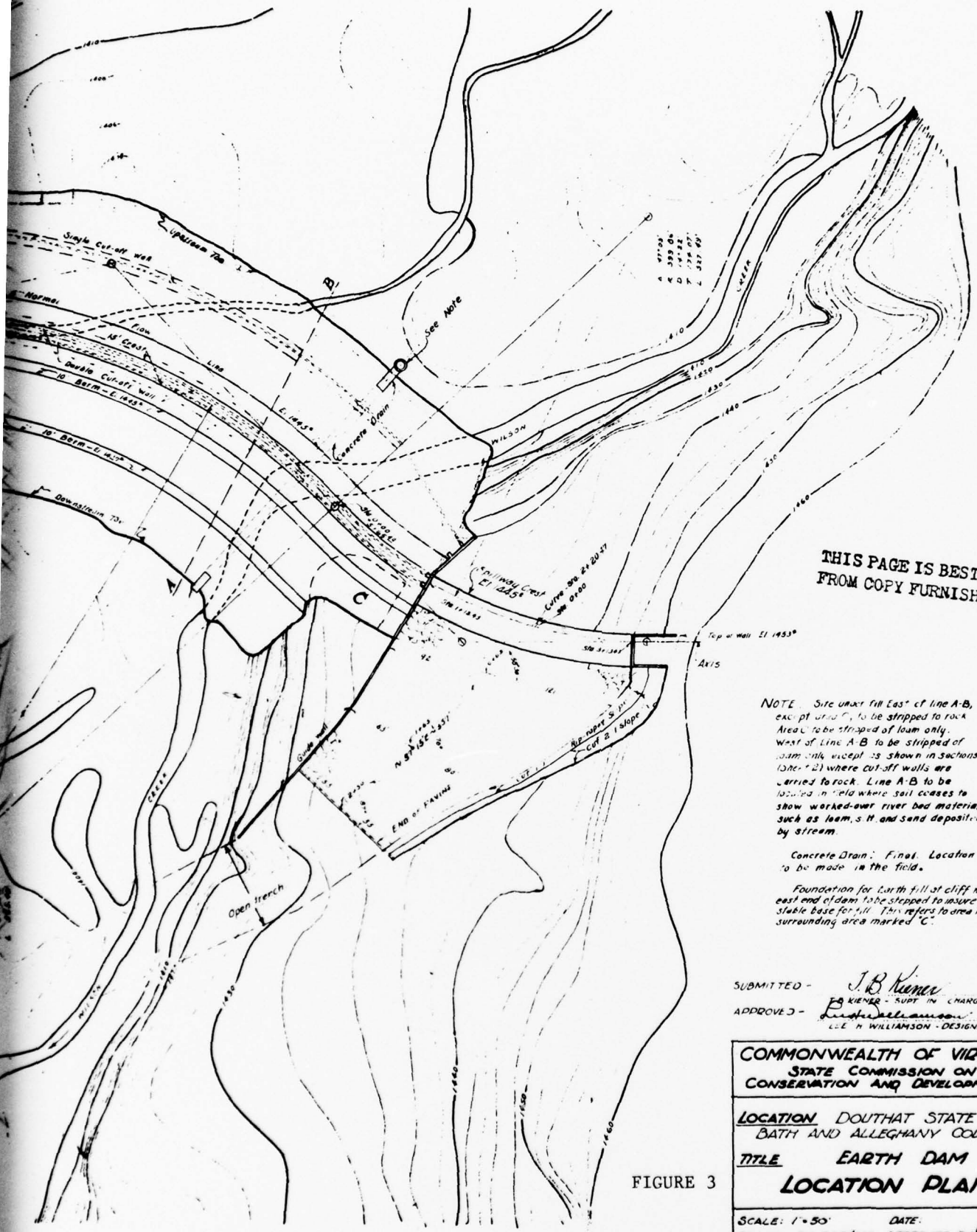
Includes Clinch sandstone and Massanutten sandstone.

SOURCE: GEOLOGIC MAP OF VIRGINIA, 1963

FIGURE 2

REGIONAL GEOLOGIC MAP SHOWING DAM LOCATION





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FROM COPY FURNISHED TO DDC

NOTE. Site under fill East of line A-B, except area C, to be stripped to rock. Area C to be stripped of loam only. West of Line A-B to be stripped of loam only except as shown in Sections (Sheet 2) where cut-off walls are carried to rock. Line A-B to be located in field where soil ceases to show worked-over river bed materials, such as loam, silt and sand deposited by stream.

Concrete Drain: Final Location to be made in the field.

Foundation for Earth fill at cliff near east end of dam to be stepped to insure more stable base for fill. This refers to area immediately surrounding area marked "C".

SUBMITTED - J. B. Kiener
J. B. KIENER - SUPT. IN CHARGE

APPROVED - Lee H. Williamson
LEE H. WILLIAMSON - DESIGNING ENGR

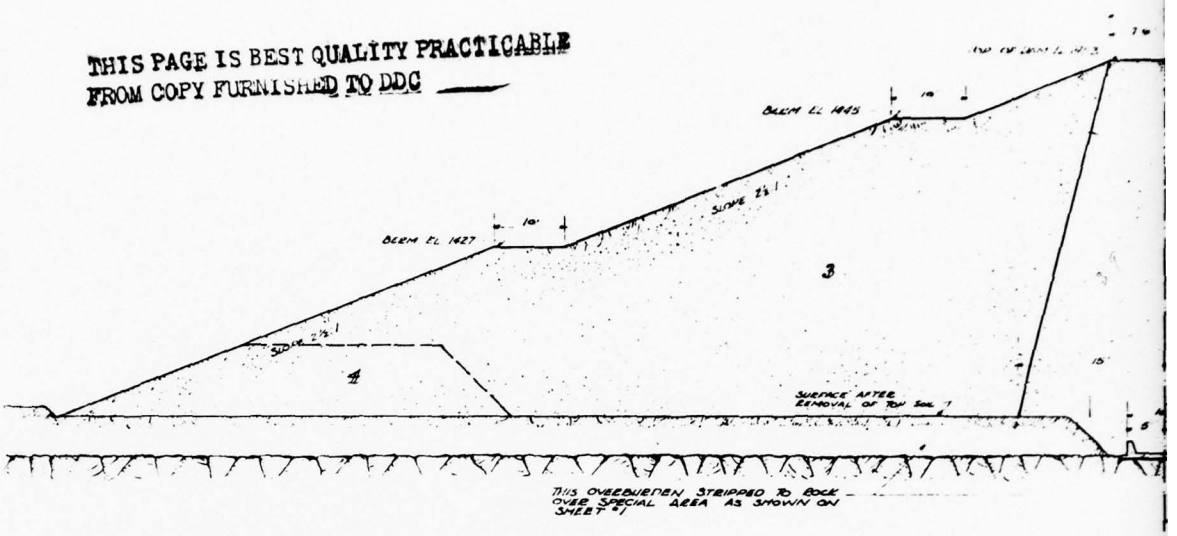
COMMONWEALTH OF VIRGINIA
STATE COMMISSION ON
CONSERVATION AND DEVELOPMENT

LOCATION DOUTHAT STATE PARK
BATH AND ALLEGHANY COUNTIES

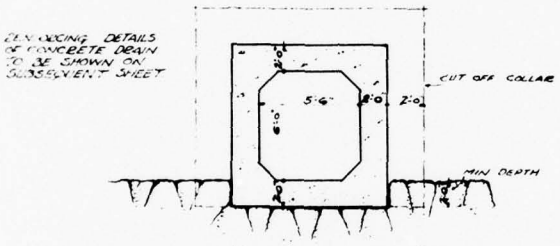
TITLE EARTH DAM
LOCATION PLAN

SCALE: 1" = 50' DATE:
DRAWN BY: GOB/ACB APPROVED BY: R. E. Burson
DRAWING NO. DR 2-1 SHEET 1 OF 5

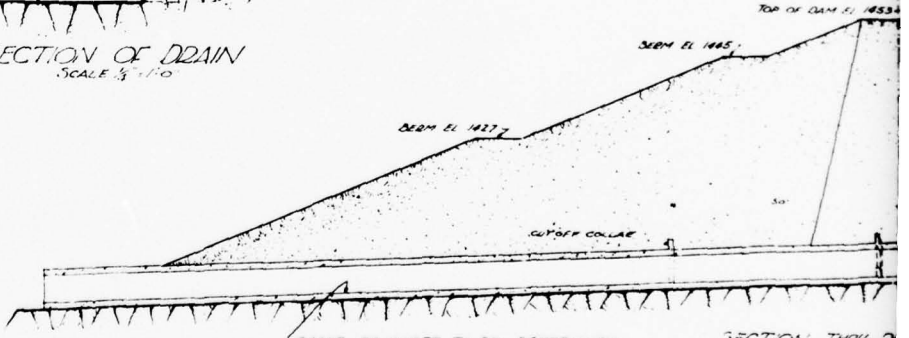
FIGURE 3



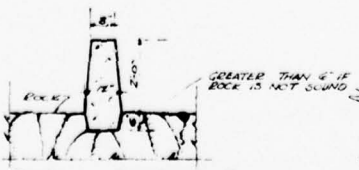
TYPICAL
SCALE



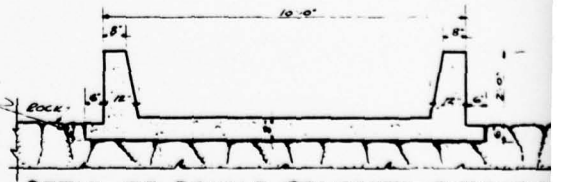
SECTION OF DRAIN
SCALE ½"=1'-0"



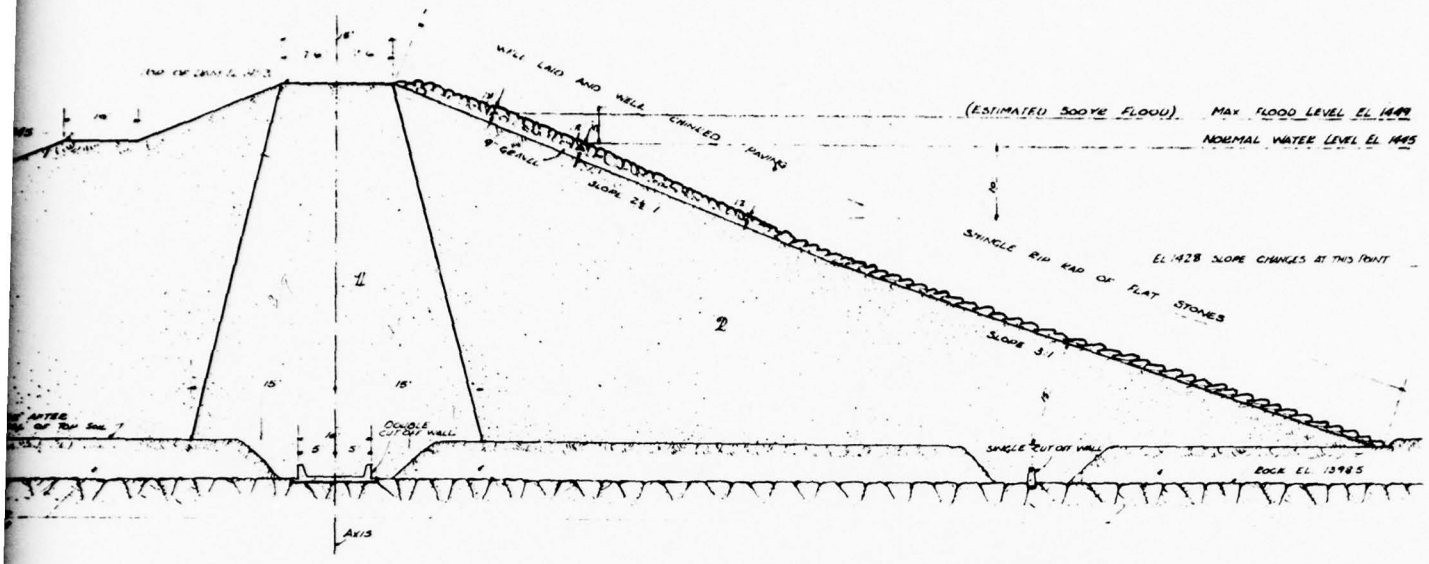
SECTION THRU D
SCALE



DETAIL OF SINGLE CONCRETE CUT-OFF WALL
SCALE ½"=1'-0"

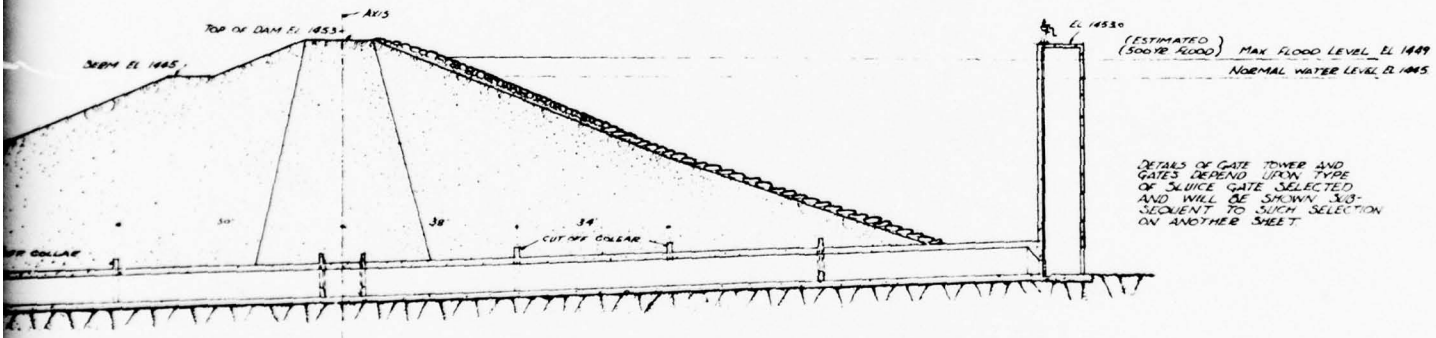


DETAIL OF DOUBLE CONCRETE CUT OFF W
SCALE ½"=1'-0"

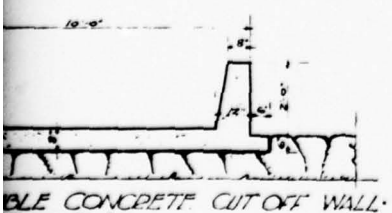


TYPICAL SECTION
SCALE 1"=10'

1. ROLLED CORE - MOST IMPERVIOUS MATERIAL OBTAINABLE.
2. UPSTREAM ROLLED FILL - BEST IMPERVIOUS MATERIAL AFTER SATISFYING 1.
3. DOWNSTREAM ROLLED FILL - AS PERVIOUS AS POSSIBLE.
4. DOWNSTREAM TOE - A VERY FREE DRAINING MATERIAL.



SECTION THRU DRAIN AND GATE TOWER
SCALE 1"=16'

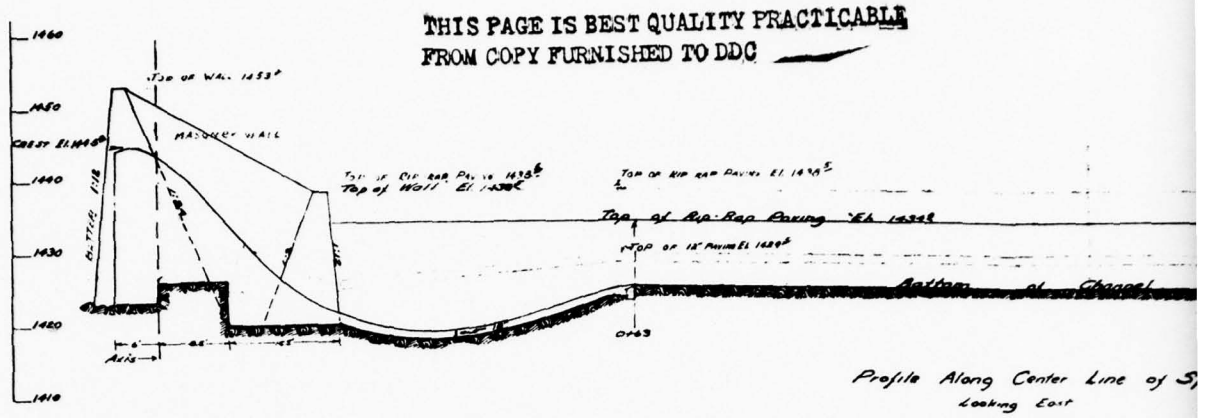


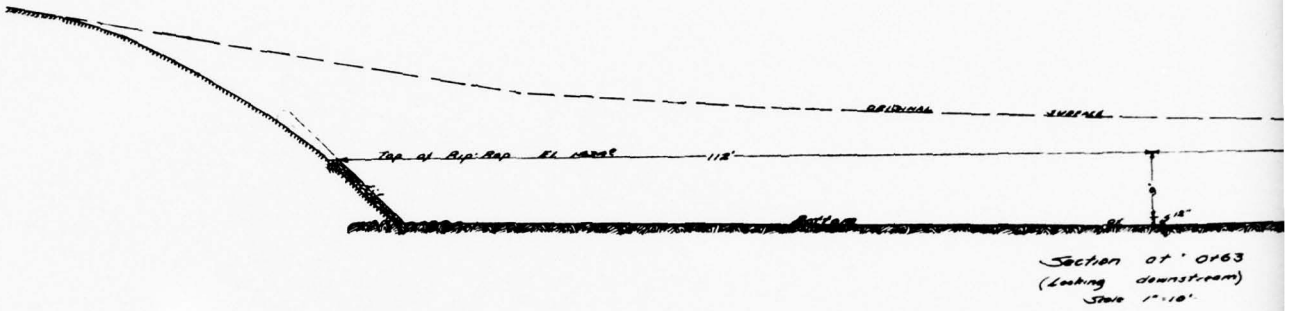
BLE CONCRETE CUT OFF WALL
SCALE ½"=1'-0"

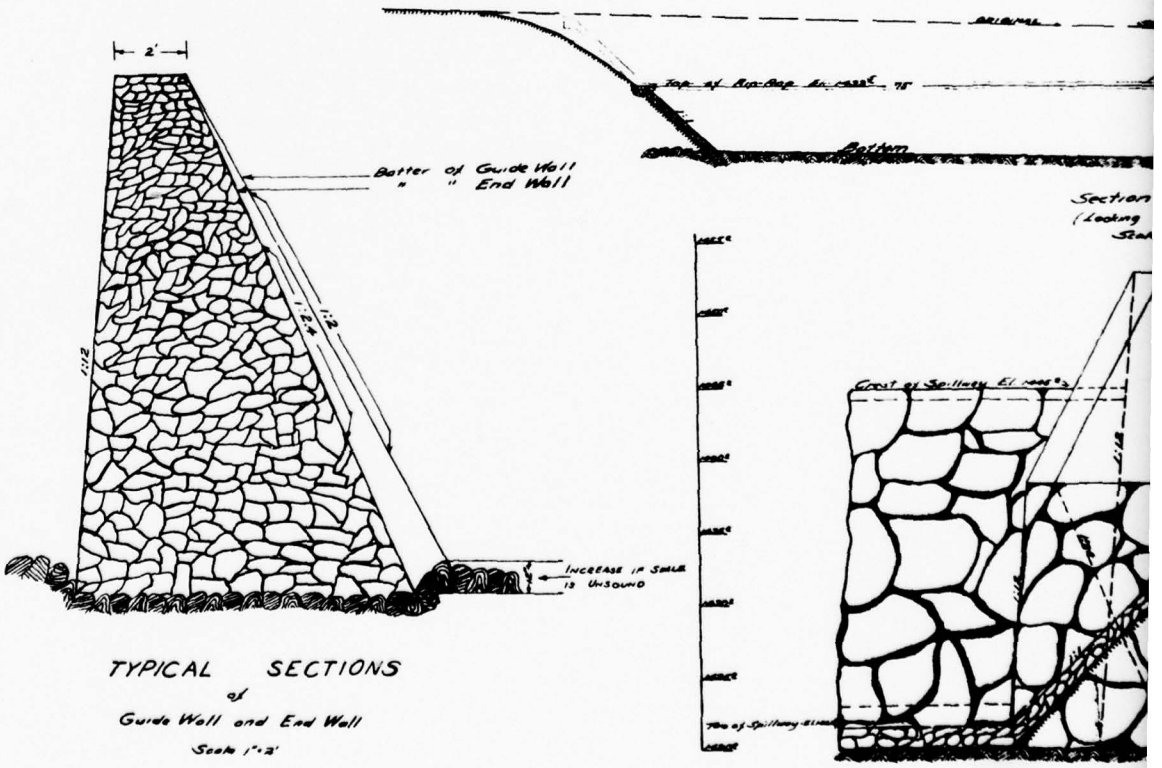
FIGURE 4

SUBMITTED – J B Kiser
TRAVELLER – SUPT. IN CHARGE
APPROVED – Lee H Williamson
LEE H. WILLIAMSON - DESIGNING ENGR.

COMMONWEALTH OF VIRGINIA STATE COMMISSION ON CONSERVATION AND DEVELOPMENT
LOCATION DOUTHAT STATE PARK BATH AND ALLEGHANY COUNTIES
TITLE EARTH DAM SECTIONS
SCALE AS SHOWN DATE: DRAWN BY C.A.L. APPROVED BY: R.E.B. DRAWING NO. DE2-2 SHEET 2 OF 5





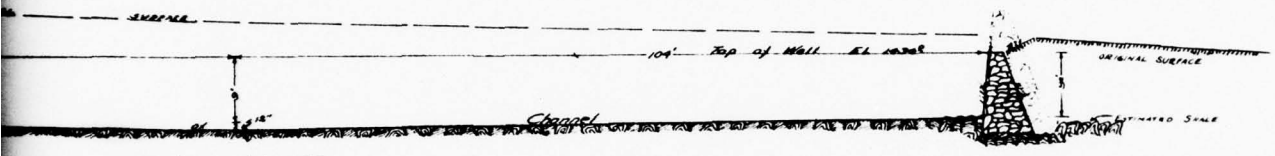


TYPICAL SECTIONS
of
Guide Wall and End Wall
Scale 1"=2'

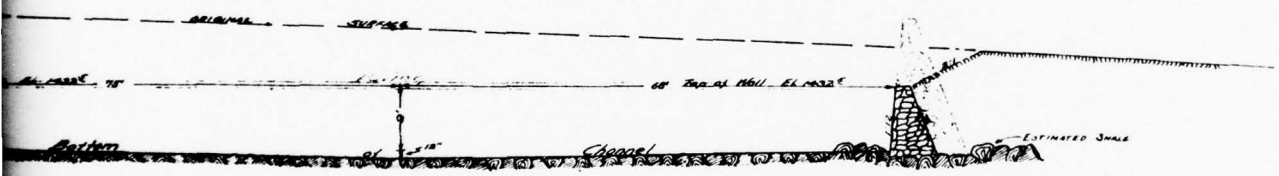
Profile Along Center Line of Spillway
Looking East
Scale 1"=10'

Note - Final grade of channel to be determined in field - to be such that flood flow shall not exceed 15 ft. per second.

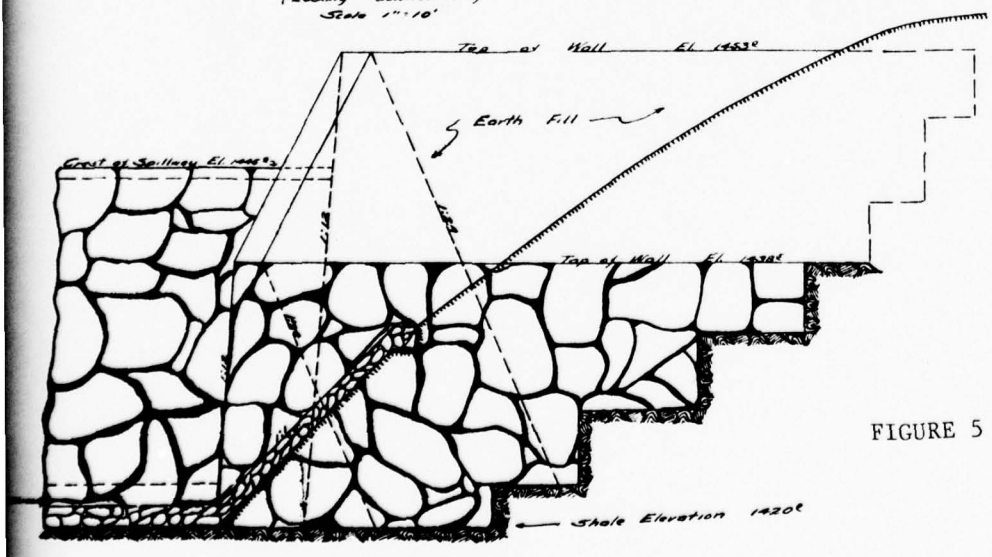
All masonry sections to be placed on 10" concrete slab.



Section at 1463
(Looking downstream)
Scale 1"=10'



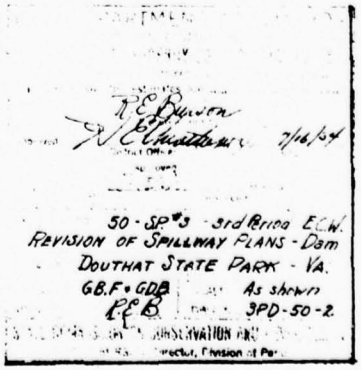
Section at 1463
(Looking downstream)
Scale 1"=10'

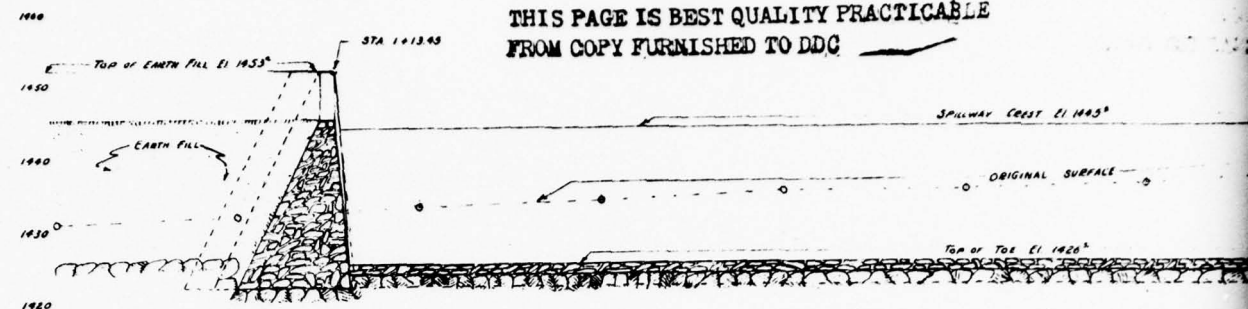


Section A-A - Looking North
Scale - 1"=5'

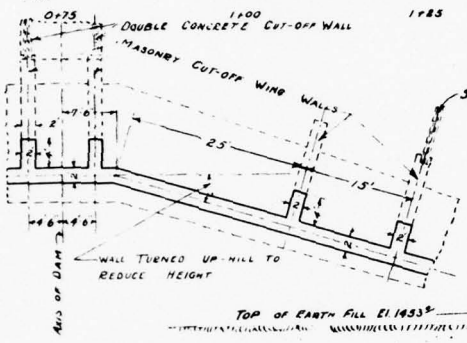
FIGURE 5

Dwg Nos 3PD-53-1&2 show changes in spillway occasioned by cutting channel to slope and eliminating paving of channel which was originally shown on Dwg No. DR2-3 This change saves expense of paving and effects reduction in several masonry sections

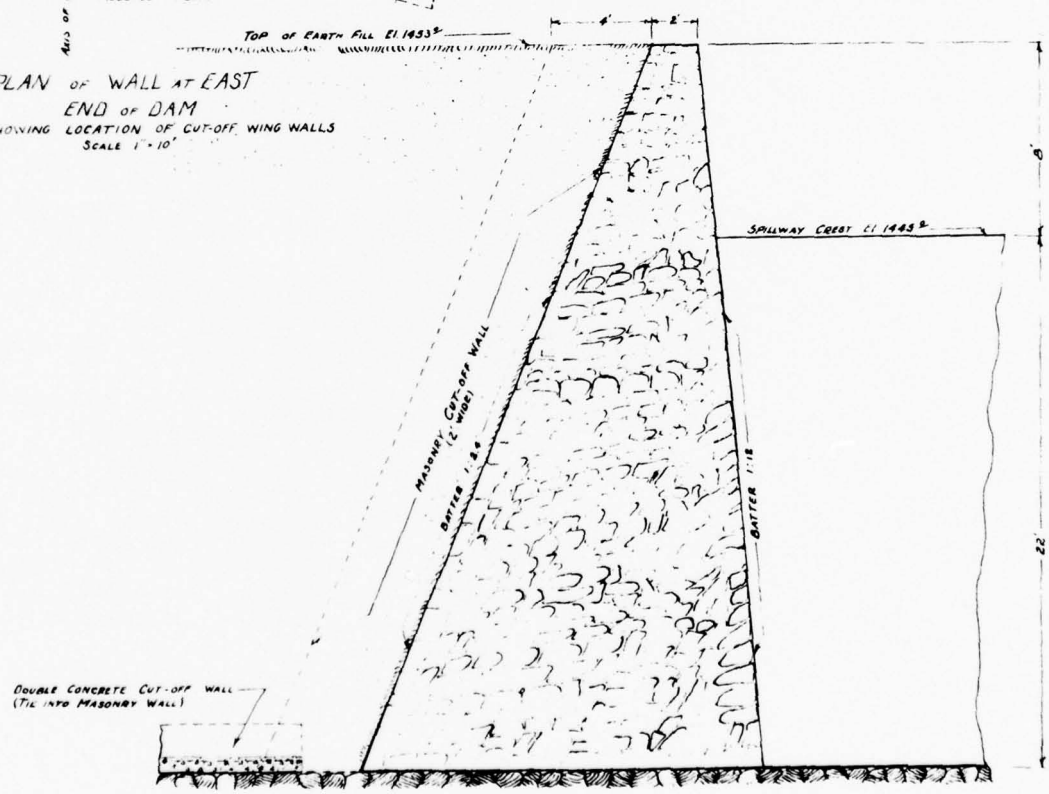




ELEVATION OF SPILLWAY
LOOKING UP STREAM
SCALE 1" = 10'



PLAN OF WALL AT EAST END OF DAM
SHOWING LOCATION OF CUT-OFF WING WALLS
SCALE 1" = 10'



SECTION OF WALL AT EAST END OF DAM
SHOWING CUT-OFF WALLS
SCALE 1" = 3'

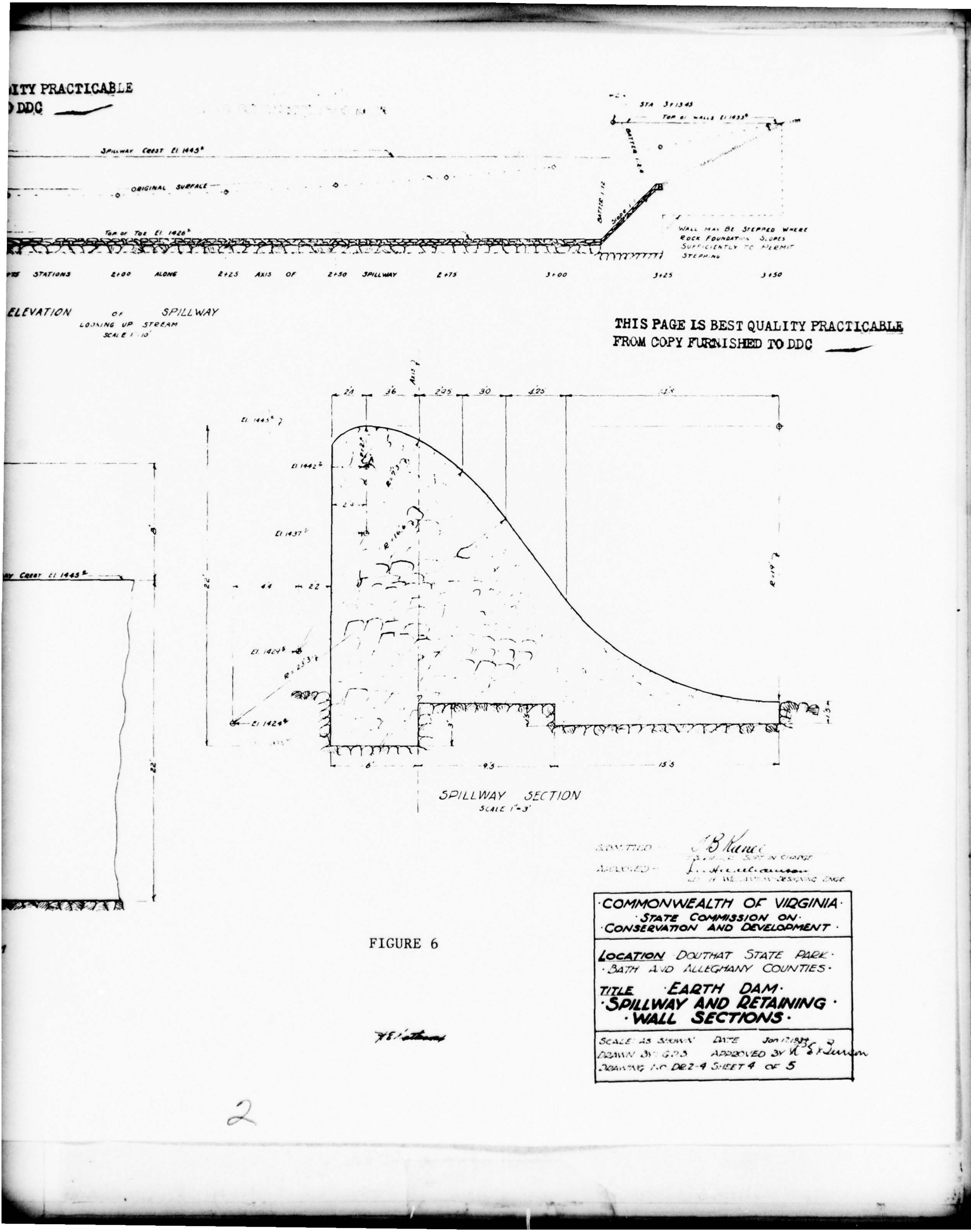


FIGURE 6

2


ROUNDED SLOPE TO MEET ORIGINAL GROUND
SPILLWAY CHANNEL
GUIDE WALL

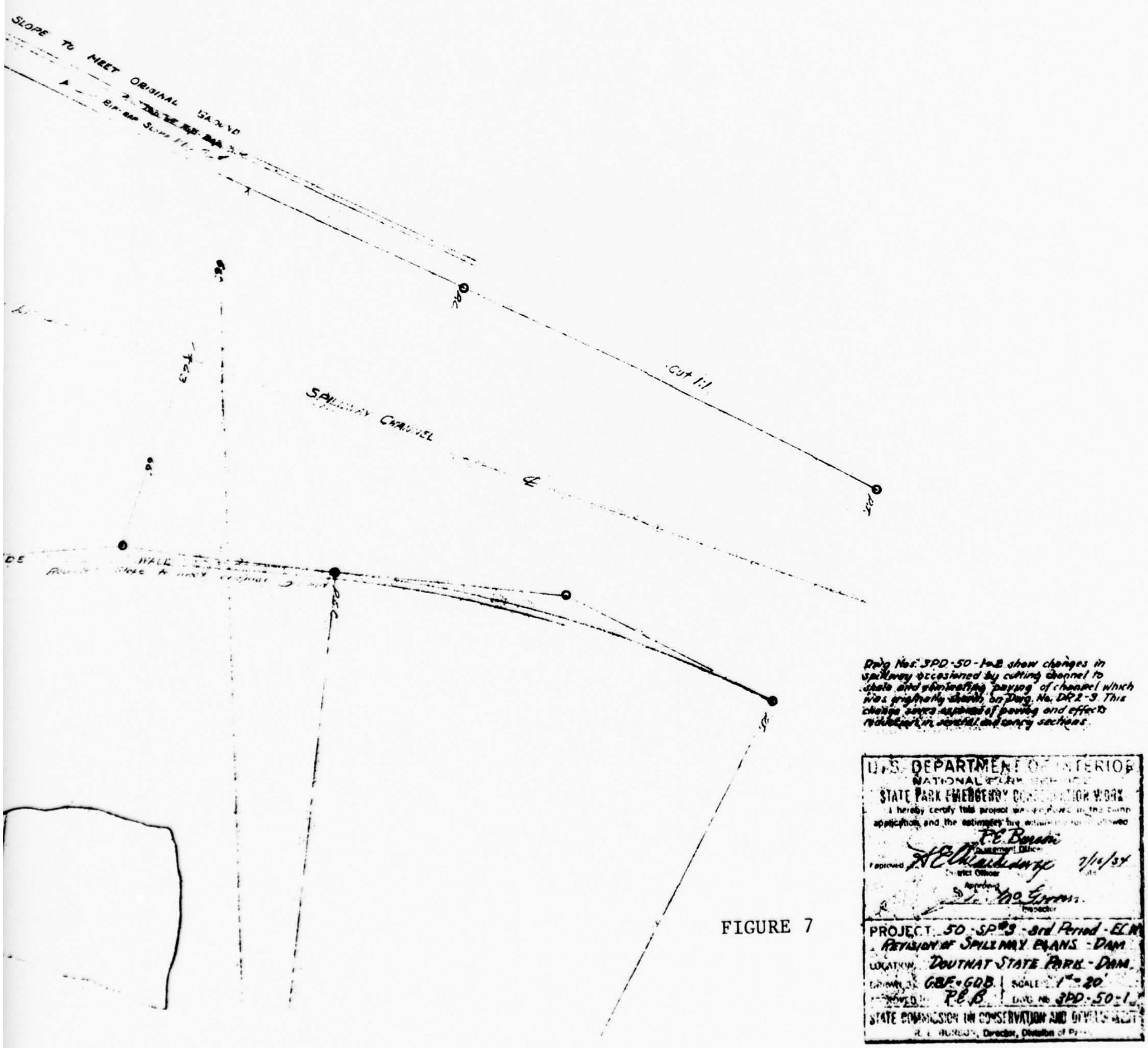

SLOPE TO MEET ORIGINAL GROUND
Cut 1:1
SPILLWAY CHANNEL
Dwg Nos. 3PD-50-1&2 show changes in spillway occasioned by cutting channel to shale and eliminating paving of channel which was originally shown on Dwg. No. DR2-3. This change saves expense of paving and effects reduction in several masonry sections.
U.S. DEPARTMENT OF INTERIOR
NATIONAL PARK SERVICE
STATE PARK EMERGENCY CONSERVATION WORK
P.E. Bonani
Approved
District Officer
7/16/34
Inspector
PROJECT: 50-SP#3 - 3rd Period - ECW
Revision of Spillway Plans - Dam
LOCATION: Doutnat State Park - Dam
GBF + GDB
SCALE 1" = 20'
P.E.B.
DWG. No. 3PD-50-1
STATE COMMISSION ON CONSERVATION AND DEVELOPMENT
Director, Division of Parks

FIGURE 7

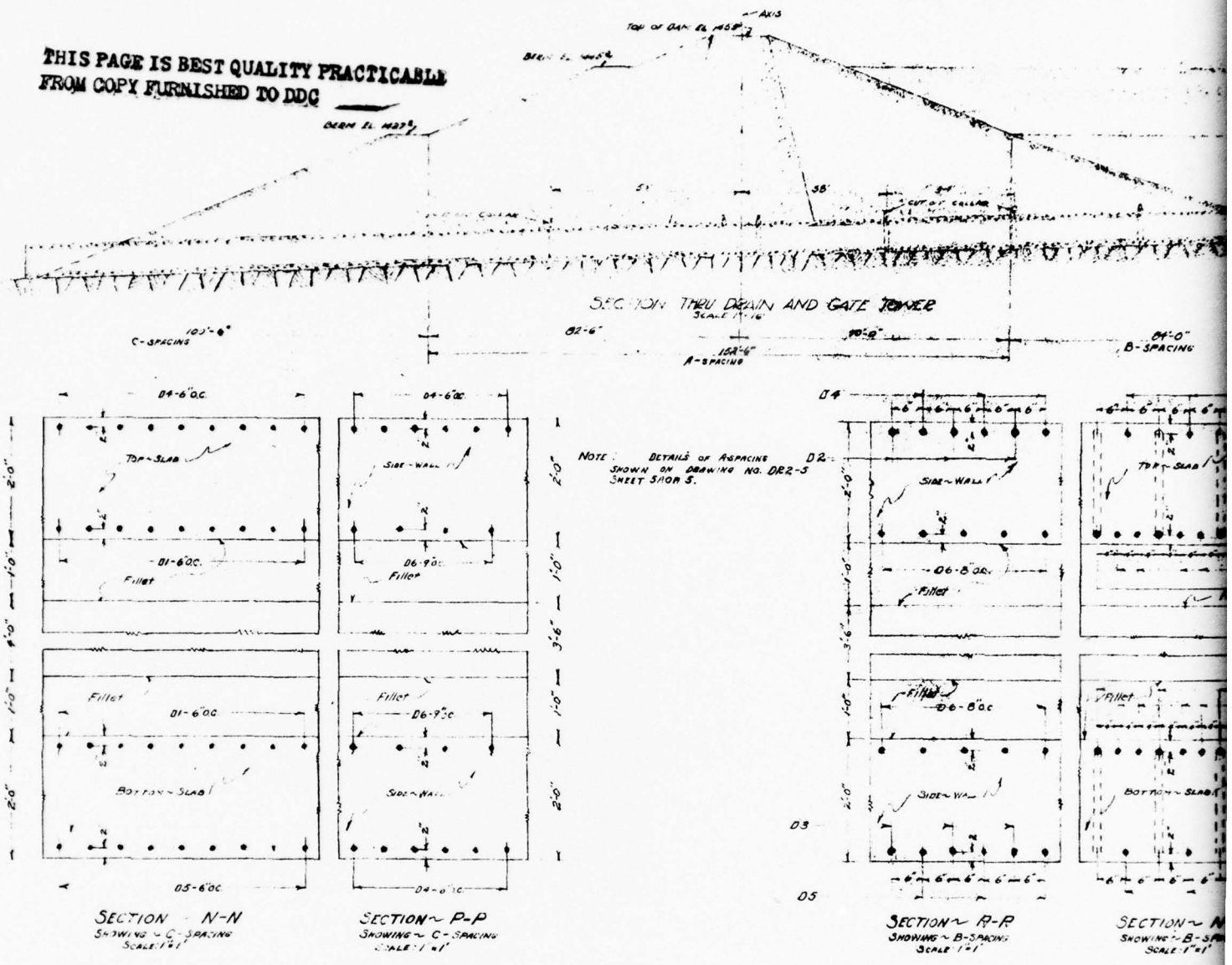


FIGURE 8

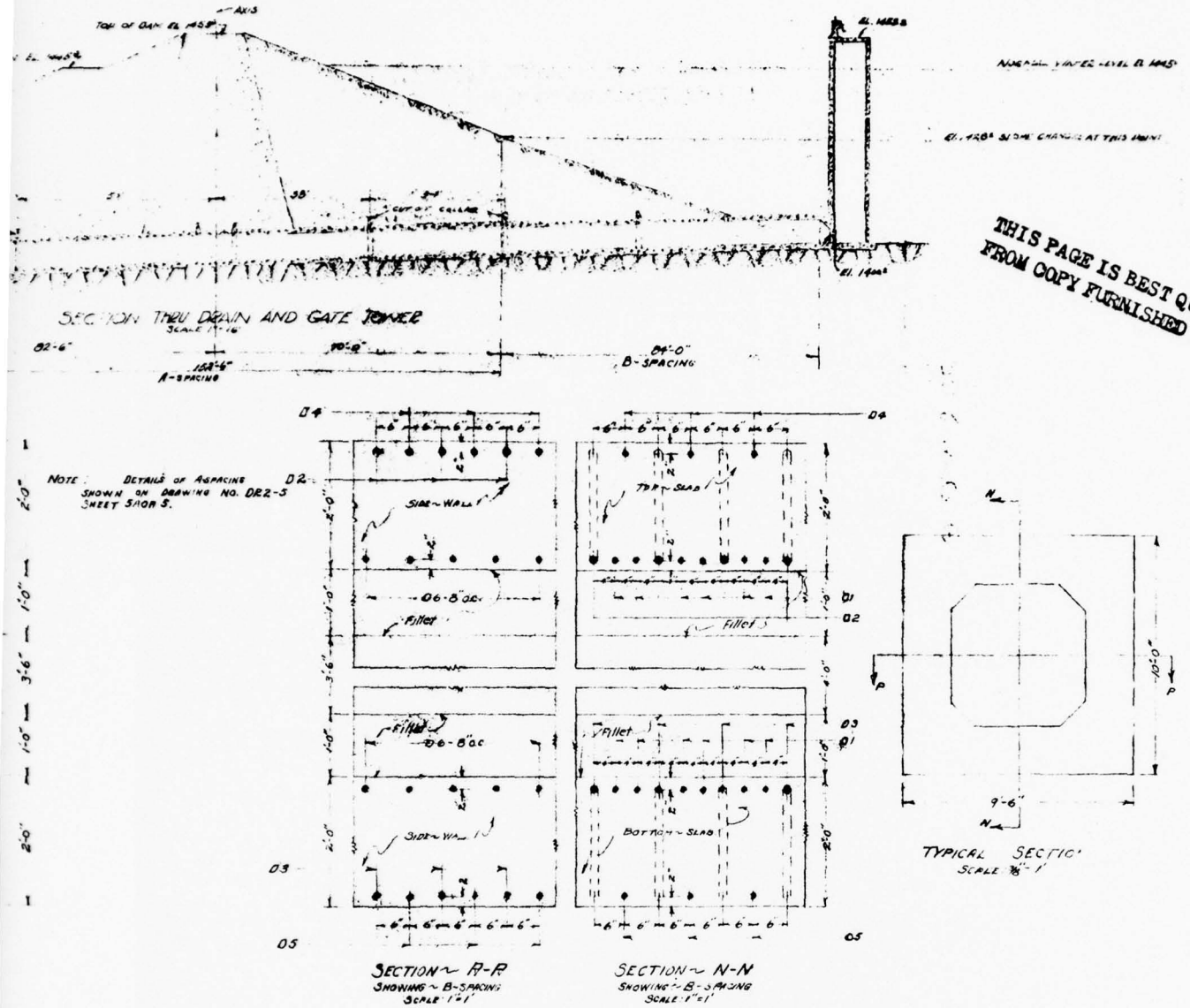


FIGURE 8

SUBMITTED - [illegible]
TENER SUPT IN CHARGE
APPROVED - [illegible]
LEE A. WILLIAMSON - DESIGNING ENGR.

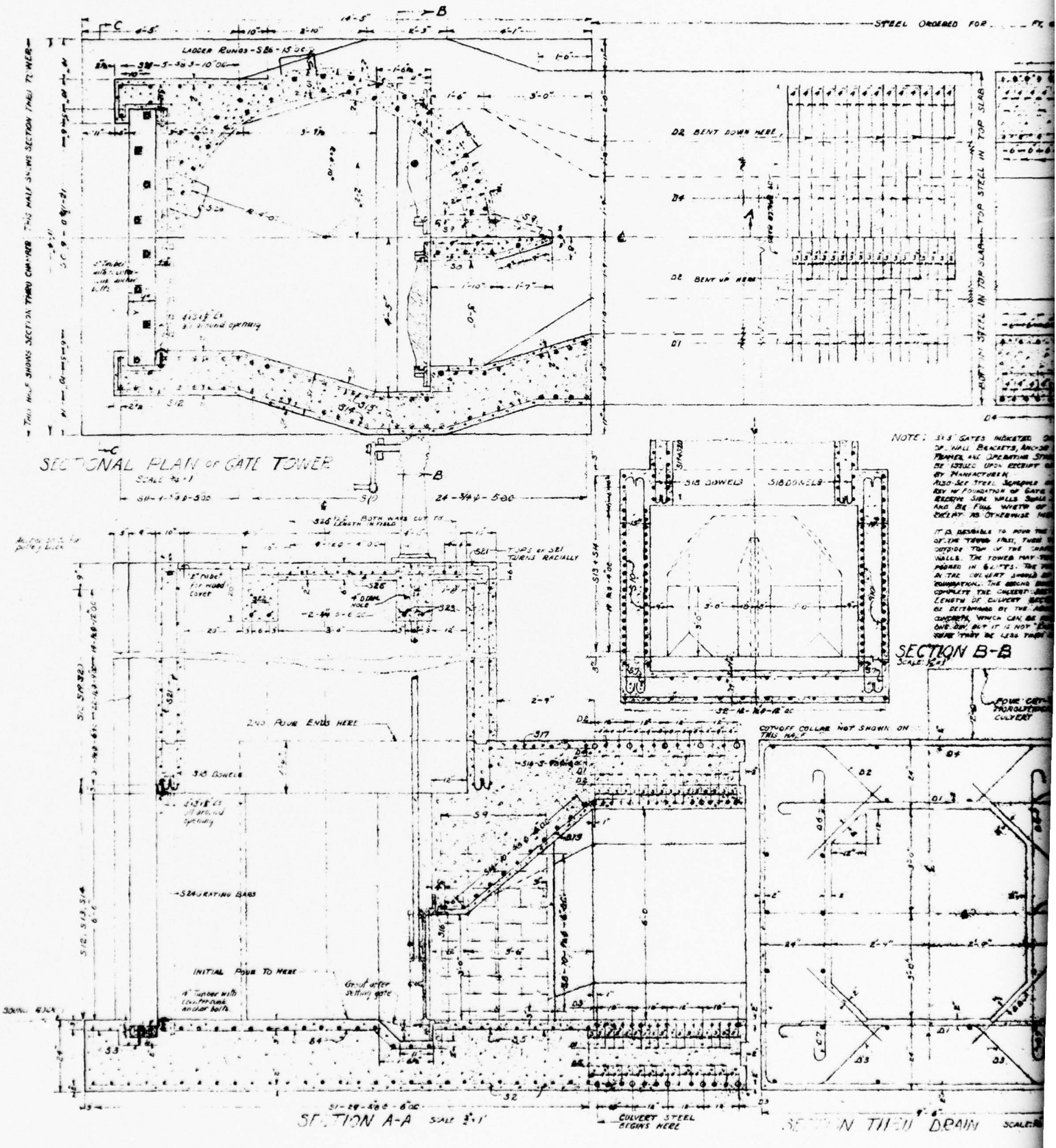
COMMONWEALTH OF [illegible]
STATE COMMISSION ON CONSERVATION AND DEVELOPMENT

LOCATION DOUTHAT STATE PARK
BATH AND ALLEGHANY COUNTIES

TITLE EARTH DAM #1
SP 3 Project 50
STEEL SPACING FOR DRAIN

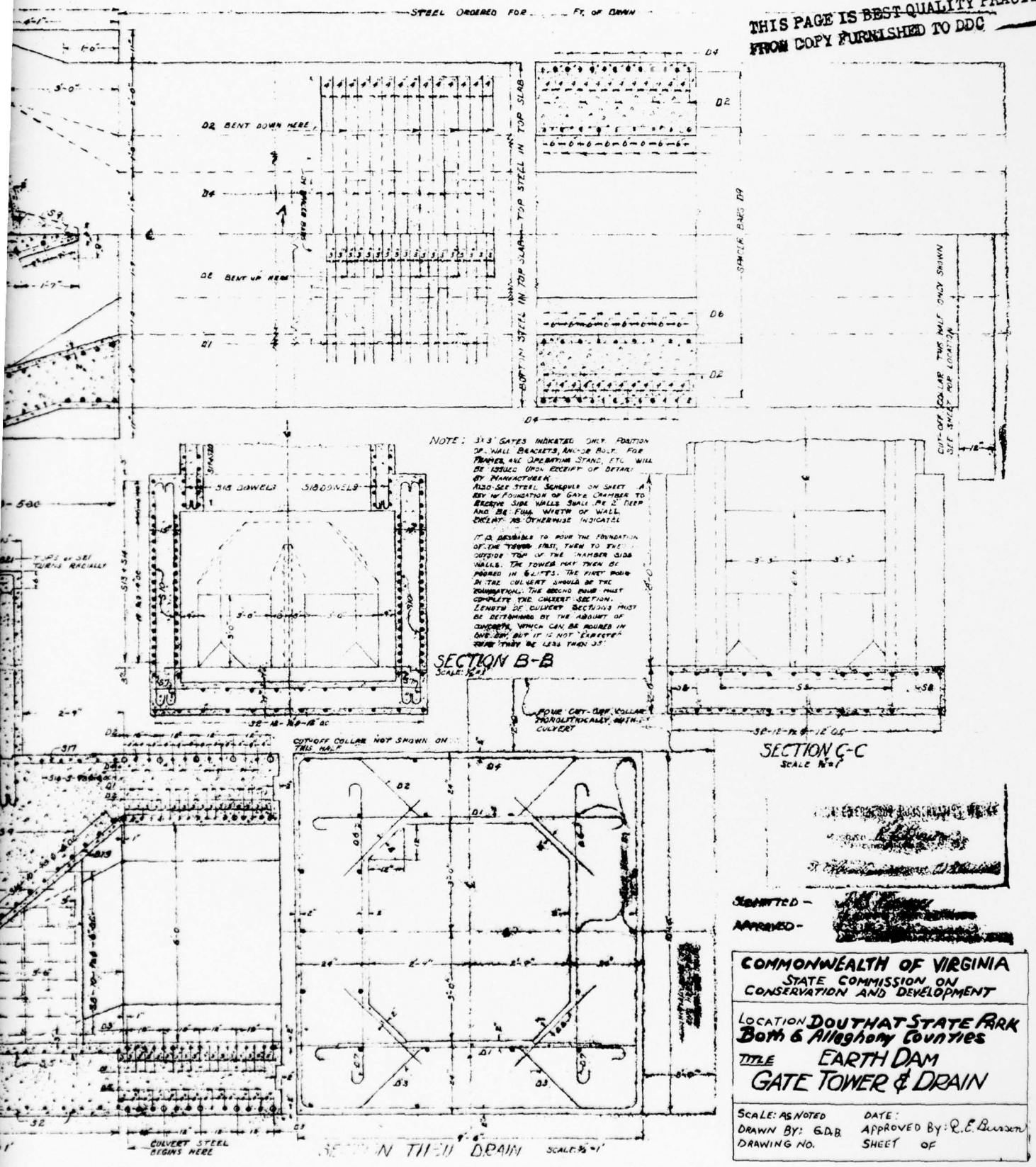
SCALE: DATE
DRAWN BY: [illegible] APPROVED BY: [illegible]
DRAWING NO. D2-3B SHEET 3B OF 5

U.S. DEPARTMENT OF [illegible]
OFFICE OF NATIONAL [illegible] DIVISION OF
STATE PARK ENG[illegible] CONSERVATION [illegible]
[illegible]



1

2



Submitted –

Approved –

COMMONWEALTH OF VIRGINIA
STATE COMMISSION ON CONSERVATION AND DEVELOPMENT

LOCATION DOUTHAT STATE PARK
Bath & Alleghany Counties

TITLE EARTH DAM
GATE TOWER & DRAIN

SCALE: AS NOTED DATE:
DRAWN BY: G.D.B. APPROVED BY: R.E. Burson
DRAWING NO. SHEET OF

FIGURE 9

APPENDIX II

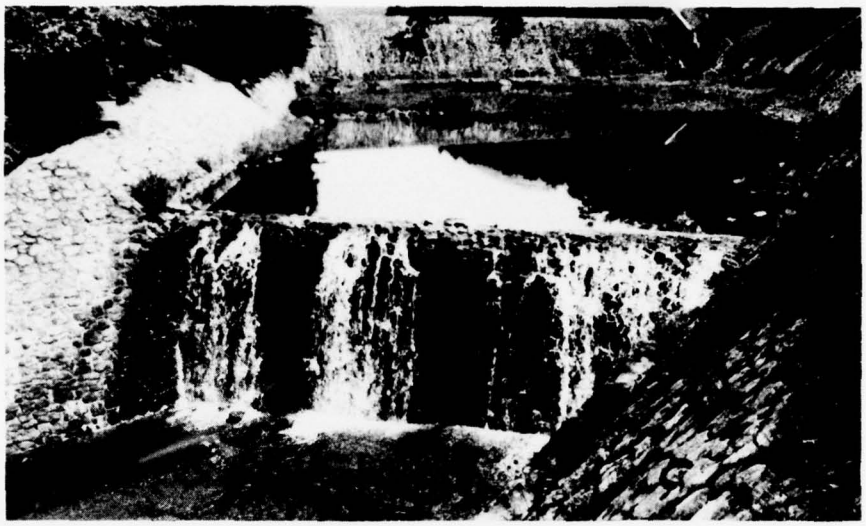
PHOTOGRAPHS

August 1978

DOUTHAT DAM EMBANKMENT FROM RIGHT ABUTMENT

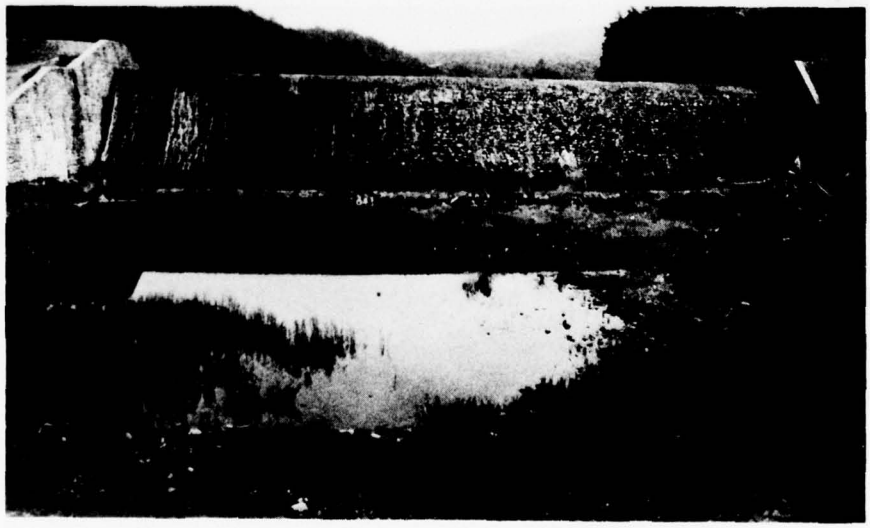
August 1978

DOUTHAT DAM - VIEW OF SPILLWAY CREST



August 1978

SPILLWAY DISCHARGE CHANNEL AND DOWNSTREAM PLUNGE POOL



August 1978

DOUTHAT DAM SPILLWAY

August 1978

OUTLET END OF CONCRETE DISCHARGE TUNNEL

APPENDIX III

FIELD OBSERVATIONS

Check List
Visual Inspection
Phase 1

Name Dam: Douthat Dam County: Bath State: Virginia Coordinators: Norfolk District U.S. Army Corps of Engineers

Date(s) Inspection: August 10, 1978 Weather: Cloudy Temperature: 78°F

Pool Elevation at Time of Inspection: Est. 1446 m.s.l. Tailwater at Time of Inspection: Unknown

III-1

Gilbert Associates, Inc.
Inspection Personnel:

Thomas E. Roberts

Thomas W. Schreffler

Fine T. Hsu

Also Present:

Ernest Barker - State Park Superintendent

Dave Lacudo - Virginia State Water Control Board

Fine T. Hsu - Recorder

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	No surface cracks of the embankment were observed.	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	No unusual movement or cracking at or beyond the toe was noticed.	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	Some scattered surface sloughing areas were observed along the downstream slope of the western half of the embankment between the upper and lower benches. None of these sloughing areas were deemed as signs of slope instability. One erosion gully (2 to 3 inches deep) extending from the crest to the downstream slope was developed at the south end of the embankment.	Most of the embankment slopes were uniformly covered by grass and well-maintained. Three single trees, 12-inch diameter, stand separately on the upstream side of the crest will need to be removed and holes repaired.
VERTICAL AND HORIZONTAL ALINEMENT OF THE CREST	Deviation in vertical and horizontal alignment of the embankment crest was not discernible from the design drawing.	
RIPRAP FAILURES	No riprap failures were observed on the embankment.	Hand-placed riprap slope is very uniform and smooth.

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
ABUTMENTS	Rocks exposed at the right abutment consist of gray to brown hard fissile shale (bedding N 50°E/55°SE), moderately jointed (N 80°W/ 85°NE) and weathered. Rocks exposed along the left bank immediately downstream is composed of decomposed fissile shale (bedding varying N 22°-25°E/40°-55°SE).	The variation in bedding attitude in shale does not imply the discontinuity of the strata and significant change in rock structure, as minor and local change in bedding attitude was seen at the outcrops on the right abutment.
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	The contact of right abutment and embankment appears to be in good condition. The contact of the spillway wall and embankment, despite barren surface condition and erosion scars, seems to be watertight.	
ANY NOTICEABLE SEEPAGE	There are two small impoundment areas beyond the downstream toe; one area, 8 feet wide by 140 feet long is located along and close to the west bank at a distance of 70 feet from the toe of the embankment, and another area, 8 feet wide and 120 feet long is located along and close to the east bank at a distance of 45 feet from the toe of embankment. Movement of water in these impoundment areas was not discernible. Therefore, seepage is only inferred in these areas.	The west impoundment area was part of original Wilson Creek prior to the existence of the dam.

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
STAFF GAGE AND RECORDER	None observed.	
DRAINS	A toe drain with free-drain material was designed in accordance with the design drawing. However, the drain material was not exposed for examination and there was no water showing at the immediate toe area.	

OUTLET WORKS

Sheet 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	No cracking or spalling of concrete surfaces in the outlet conduit was observed.	
INTAKE STRUCTURE	The intake gate tower structure in the reservoir was not inspected because of inaccessibility at the time of inspection. Reportedly one gate is jammed in an open position and is sealed with sand bags.	
OUTLET STRUCTURE	A concrete conduit, 5-1/2 feet by 6 feet, was seen at the outlet near the downstream toe area. The drain was discharging water at an estimated rate of 100-150 g.p.m. and the water has high in iron oxide content as indicated by an orange and rust color and precipitation along the paths.	
OUTLET CHANNEL	The channel was trenched in the natural sand and gravel deposits in the valley bottom. A small beaver dam was constructed in the channel but it would not significantly affect the outlet discharge capacity.	
EMERGENCY GATE	None.	

UNGATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MASONRY WEIR	The masonry weir of Ogee type has shown the following conditions:	Rehabilitation of the weir surface should be continued.
	The crest and uppermost part of the weir surface have been repaired, and the lower surface, showing local and minor failure of the masonry paving at the mid-height, will need repair work.	All seepage should be monitored for any change inflow and studied for its erosional effect to the stability of the wall.
	A minor seepage of 1 to 2 g.p.m. was observed at the downstream base area behind the left wall.	
	Several bright-brown stained areas on the spillway face at the mid-heights indicate the existence of seepage condition. The amount of seepage was not estimated due to difficult access to the area.	
APPROACH CHANNEL	None	
DISCHARGE CHANNEL	The bottom and side slope (1 vertical to 1 horizontal) on the hillside were paved with riprap. A portion of riprap side slope for an estimated distance of 20 feet in the vicinity of the weir has totally failed.	The failed riprap slope should be restored in the near future.
BRIDGE AND PIERS	None.	

INSTRUMENTATION

Sheet 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	None observed.	
OBSERVATION WELLS	None observed.	
WEIRS	None observed.	
PIEZOMETERS	None observed.	
OTHER		

RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	Reservoir slopes are gentle to moderately steep and heavily wooded. Major landslides around the reservoir area were not observed from the dam crest.	
SEDIMENTATION	Excessive sedimentation in the reservoir area near the dam was not observed.	

DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	The channel was trenched in the original gravelly streambed. There is a small bridge (2 to 3 feet high) across the channel at the distance of about 800 feet below the dam, which consists of several drainage pipes cast in a concrete mass. No significant obstructions to the flow were observed within a length of 1,000 feet of the channel. Dense trees are growing on the both banks of the channel. Masonry wall of plunge pool at lower end of spillway channel was washed out.	
SLOPES	The streambed has an average gradient of 0.0143 measured from the USGS 7-1/2-minute quadrangle. Excessive channel erosion was not evidenced.	
APPROXIMATE NUMBER OF HOMES AND POPULATION	In accordance with USGS 7-1/2 minute quadrangle (photorevised 1969), there are approximately 50 homes scattered along the Wilson Creek within 6 miles below the dam. Further downstream, the town of Cliftondale Park, consisting of about 100 homes, is located on the right bank of the creek.	

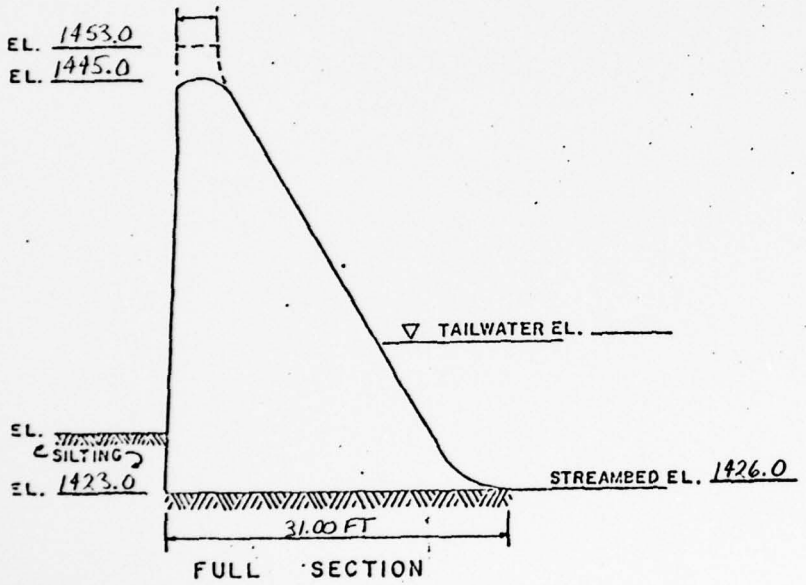
APPENDIX IV

STABILITY CALCULATIONS

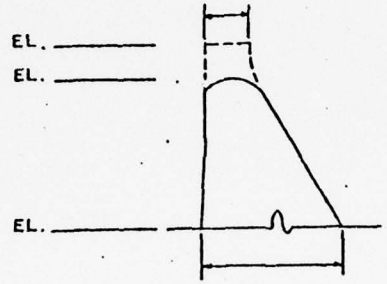
GRAVITY DAM DESIGN
STABILITY ANALYSIS

ANALYSIS DONE ON X FULL SECTION ___ PARTIAL SECTION
LOCATION OF SECTION DOUTHAT STATE PARK - SPILLWAY
ANALYSIS PREPARED BY D.C. BEECHWOOD

LOADING CASE	ELEV. HEAD WATER	ELEV. TAIL WATER	ΣV	ΣH	ΣH/ΣV	LOCATION RESULTANT FROM TOE	% BASE IN COMPRESSION	FACTOR SAFETY SLIDING	FOUNDATION PRESSURE	
									TOE	HEEL
PMF	1455.8	1426.0	14.9 K/FT	29.8 K/FT	2.00	6.58 FT	64%	4.27	1.51 KSF	0. KSF
½ PMF	1453.2	1426.0	17.6	26.3	1.49	10.86	100%	4.92	1.08	0.06
NORMAL WATER LEVEL + ICE	1445.0	1424.5	27.0	20.1	0.74	14.34	100%	6.78	1.07	0.68



FULL SECTION



PARTIAL SECTION

APPENDIX V

REFERENCES

APPENDIX V

REFERENCES

1. Recommended Guidelines for Safety Inspection of Dams, Appendix D, Washington, D.C., Department of the Army, Office of the Chief of Engineers.

2. HEC-1 Flood Hydrograph Package, Hydrologic Engineering Center, U.S. Army Corps of Engineers, January 1973.

3. "Seasonal Variation of the Probable Maximum Precipitation East of the 105th Meridian," Hydrometeorological Report No. 33, (U.S. Weather Bureau, April, 1956).

4. "Rainfall Frequency Atlas of the United States," Technical Paper No. 40, (U.S. Weather Bureau, May, 1961).

5. Design of Small Dams, (U.S. Department of the Interior, Bureau of Reclamation, Second Edition, 1973).

6. The Geologic Map of Virginia, 1963, Division of Mineral Resources, Commonwealth of Virginia.

APPENDIX VI

CONDITIONS

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CONDITIONS

This Report is based on a visual inspection of the dam, a review of available engineering data and a hydrologic analysis performed during a Phase I Investigation as set forth in the U.S. Corps of Engineers' "Recommended Guidelines for Safety Inspection of Dams" and the contract between the U.S. Corps of Engineers and Gilbert Associates, Inc.

The foregoing inspection, review and analysis are by their nature limited in scope. It is possible that conditions exist which are hazardous, or which might in time develop into safety hazards, that are not detectable by this inspection, review and analysis. Accordingly, Gilbert Associates, Inc. cannot and does not warrant or represent that conditions which are hazardous, or which may in time develop into safety hazards, do not exist.